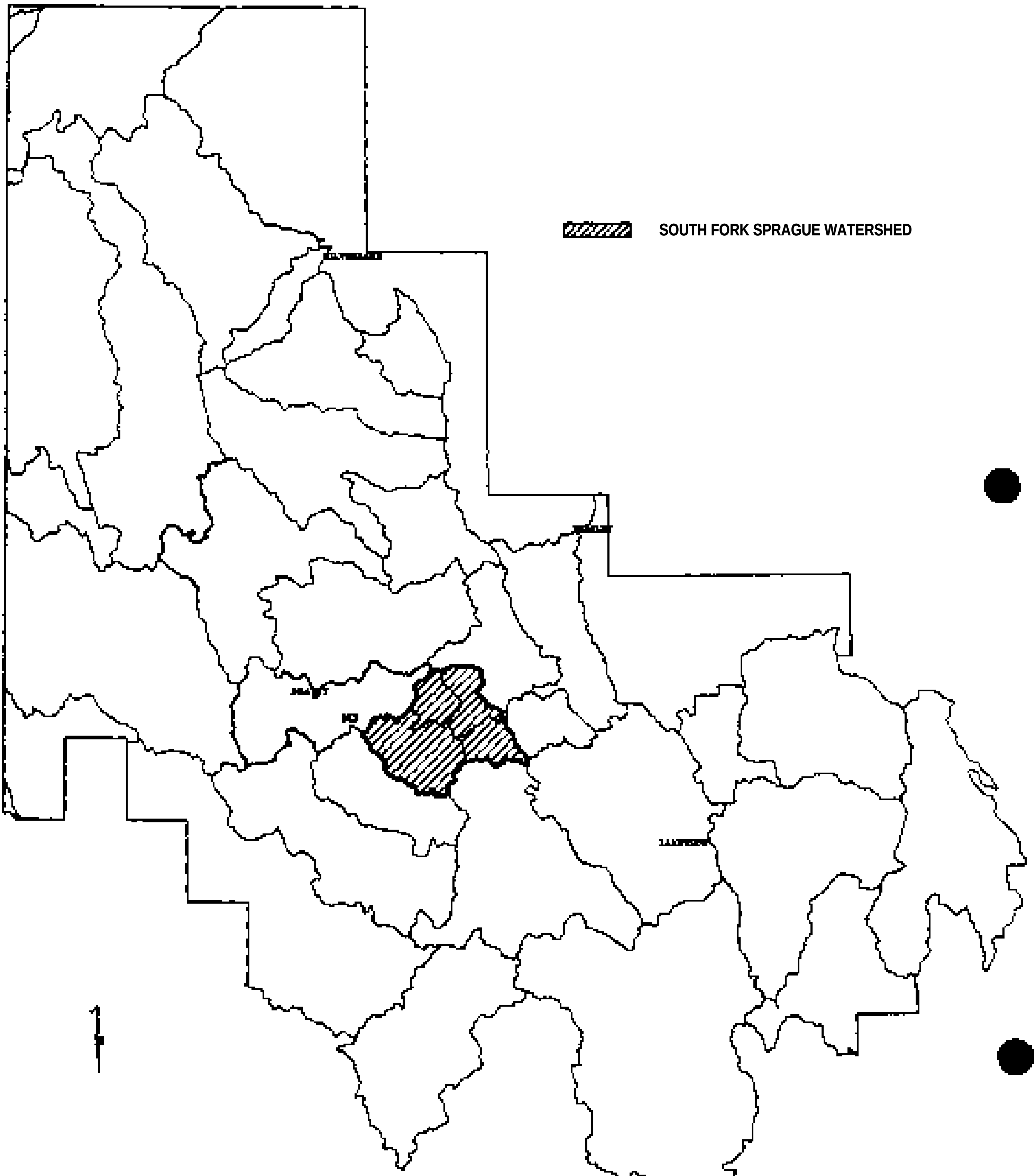
South Fork Sprague Watershed Ecosystem Analysis Report

Fremont National Forest
Bly Ranger District

June 1995

FREMONT FOREST WATERSHEDS



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CHAPTER I

INTRODUCTION

ECOSYSTEM ANALYSIS REPORT

FOR THE
SOUTH FORK SPRAGUE RIVER WATERSHED

I. INTRODUCTION

The Fremont National Forest Land and Resource Management Plan (Forest Plan) provides direction for management of resources and outlines Standards and Guidelines for use in implementing projects. The Forest Service is concerned that the Standards and Guidelines may not go far enough to maintain the desired condition outlined in the Forest Plan. We also believe it is necessary to better define the desired condition so that it is specific to each watershed. To do this we must shift our focus from individual projects to a landscape view of the watershed. It is not the intent of this analysis to change the Forest Plan. If needed changes do become evident, then an amendment will be prepared. Any amendment will include public involvement and follow National Environmental Policy Act (NEPA) regulations. Our goal, and the Forest Plan desired condition, is to have a healthy forest ecosystem which provides sustainable beneficial uses **(see** beneficial uses section-Chapter II) to the public. Our Forest Plan currently looks at the natural resources and beneficial uses separately, which is a segmented approach to management. Watershed analysis looks at the ecosystem as a whole, not just the individual parts.

This ecosystem analysis report presents a current understanding of the processes and interactions of concern occurring within the South Fork Sprague River watershed on the Bly Ranger District, Fremont National Forest. It is intended to help us understand how past land-use activities interact with the physical and biological environments in the watershed. This analysis provides a logical way to learn more about how ecological systems function within the watershed by incorporating knowledge specific to the watershed into our planning process. This information is essential to protect beneficial uses and to protect and sustain the natural systems that society depends on. The analysis provides a vehicle to efficiently identify and balance multiple concerns. The analysis will provide a summary of trends in resources where restoration actions are needed and a checklist to ensure relevant topics are not overlooked during project analysis.

The analysis used existing information, therefore some information team members wanted was not available to assist in describing conditions, predicting trends, or evaluating relationships. The Data Gaps section (Chapter VI) outlines data that would improve this analysis and aid evaluation of future activities. The analysis focuses on specific issues, values and uses identified within the watershed that are essential for making sound management decisions. Historic, current, and desired condition of the watershed while also describing processes and activities affecting resources in the watershed.

The analysis was conducted by an eight member core-team (consisting of a soil scientist, hydrologist, wildlife biologist, silviculturist, and others-see appendix for listing of members and experience) and followed the eight step process outlined in the "Federal Agency Guide for Pilot Watershed Analysis." This document is written for the Bly District Ranger. Although the public is free to receive and review the analysis, it will only be sent to those who specifically request copies. The public will be encouraged to participate in the planning of specific projects as they are proposed by the Bly Ranger District.

The Bly Ranger District will use this analysis to select specific projects that will move the watershed toward the desired condition described in this analysis and the Forest Plan. These projects will then be addressed through separate analyses conducted on a project-by-project basis by an ID Team. The project analysis process will include involvement by the general public and result in a site specific decision as required by NEPA.

CHAPTER II

DESCRIPTION OF WATERSHED AREA

ECOSYSTEM ANALYSIS REPORT
FOR THE
SOUTH FORK SPRAGUE RIVER WATERSHED

II. DESCRIPTION OF THE WATERSHED AREA

A. General Watershed Characteristics

The watershed is on the southeastern edge of the East Cascades of Oregon within the Basin and Range Physiographic Province. The area lies in the transition between coniferous forest and sagebrush steppe and has characteristics of both vegetative zones. The watershed area encompasses approximately 82,100 acres, and is five miles east of the town of Bly (Map #1). Ownership is comprised of 43,140 acres (53%) of public lands administered by the Forest Service and 38,960 acres (47%) of private interest, primarily Weyerhaeuser Company lands (Map #2). Approximately 27,150 acres are within Klamath County and 54,950 acres are within Lake County (Map #2). The watershed area is also within both Klamath Basin Working Circle (78,520 acres) and the Lakeview Federal Sustained Yield Unit (Lakeview Working Circle-3,580 acres). A significant amount of timber harvest, road construction and cattle\sheep grazing has occurred in all management areas in the past.

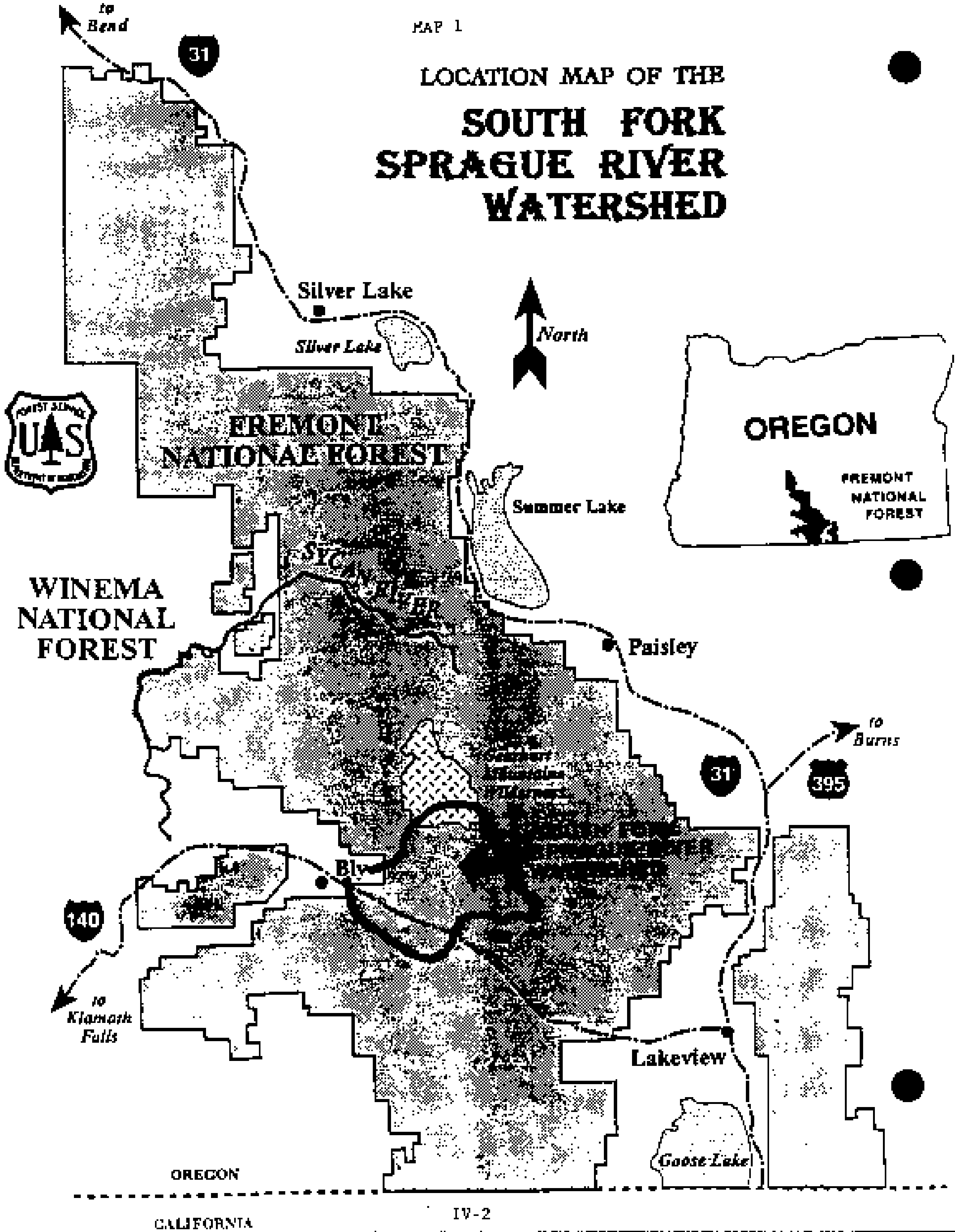
Road densities within the watershed average 3.95 miles\square mile on Forest Service lands and 2.05 miles\square mile (this figure includes only major roads minor service roads were not included) on private lands.

Elevations range on the extreme north end (within the Gearhart Mountain Wilderness) from 8,370 feet from the top of Gearhart Mountain to 4,340 feet along Paradise Creek (Map #3). There are 103 miles of streams on Forest Service lands and 111 miles on private lands. The watershed has typically gentle topography. The slope on approximately 58,500 acres (71% of area) is between 0 and 15%, the slope on about 21,000 acres (26% of area) is between 16 and 35%, and only about 2,600 acres (3% of area) has slopes over 35%. Portions of the South Fork Sprague River, lower Buckboard Creek and most of Brownsworth Creek flow through canyonlands that are up to 400 feet deep, and have steep to very steep side walls.

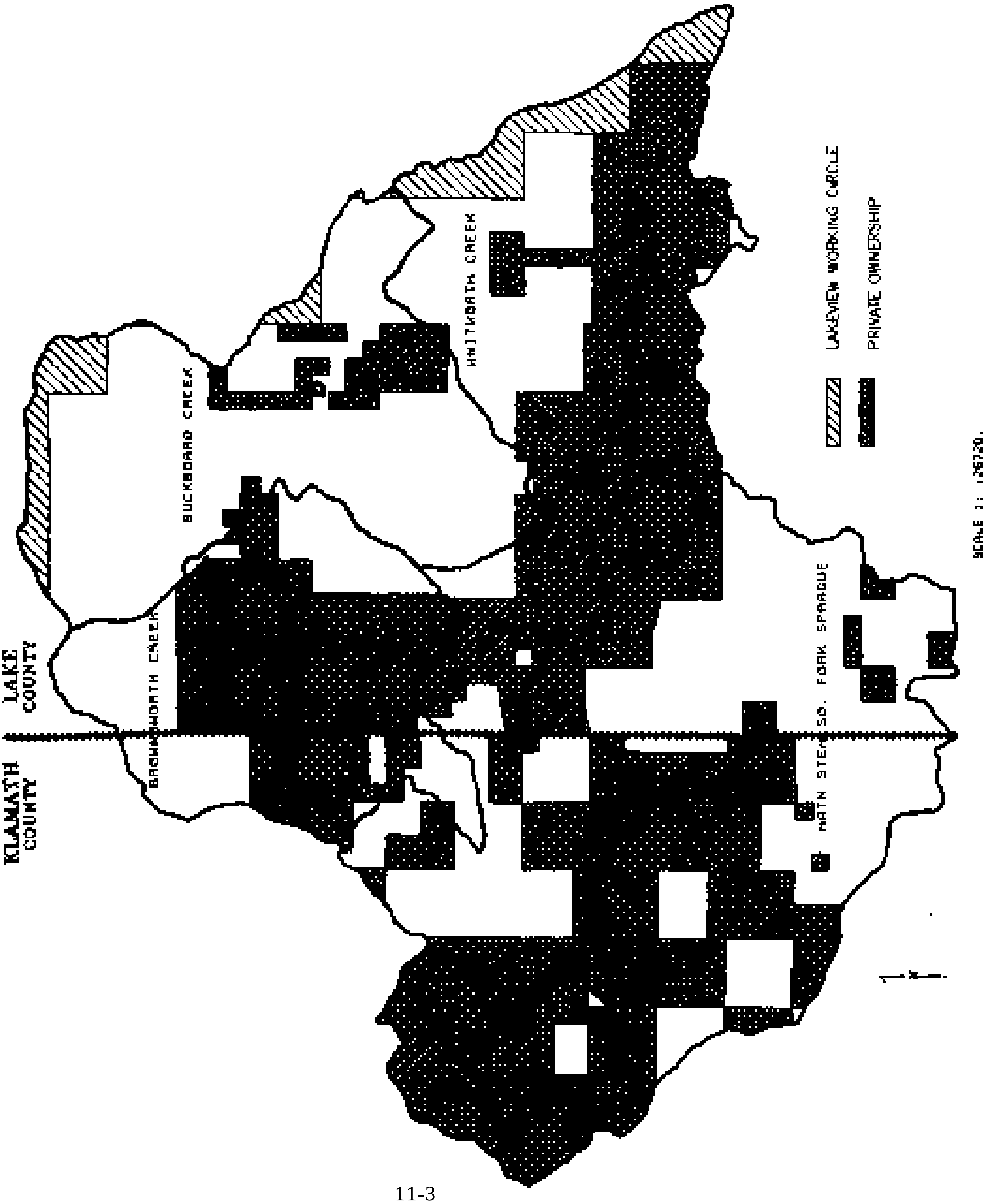
The South Fork Sprague River flows westerly until it meets the North Fork Sprague northwest of Bly to form the Sprague River. The South Fork Sprague River is one of the many headwaters of the Klamath River which flows into the Pacific Ocean near Requa, California.

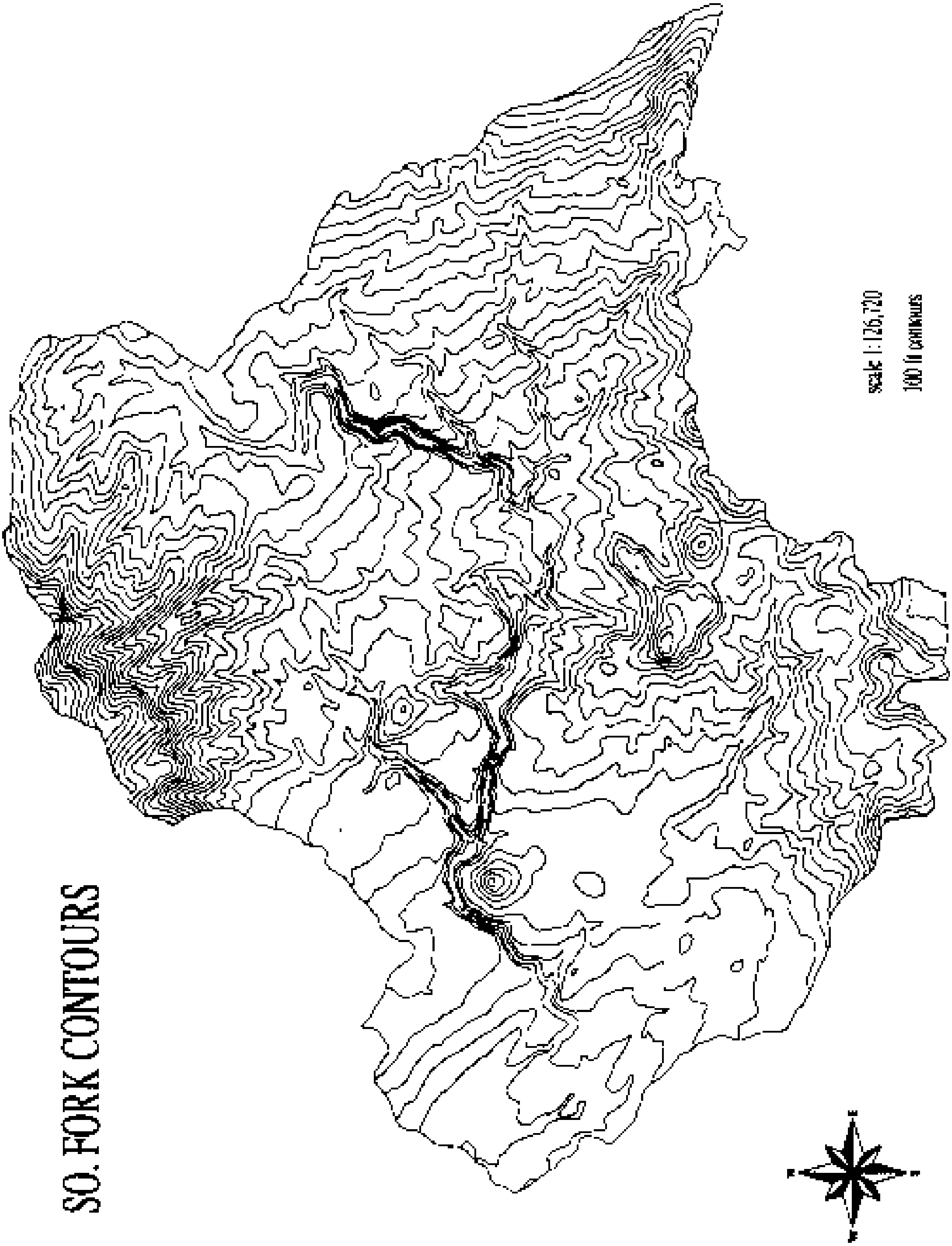
MAP 1

LOCATION MAP OF THE SOUTH FORK SPRAGUE RIVER WATERSHED



M A P # 2
SOUTH FORK SPRAGUE WATERSHED
L A N D O W N E R S H I P
WORKING CIRCLE BOUNDARY

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1. Location and Land Management

The ecosystem analysis area is near the eastern boundary of the Bly Ranger District of the Fremont National Forest. The analysis area is also south of the Gearhart Mountain Wilderness Area. The legal description includes sections or portions of sections in T35S, R16E; T36S, R14-15-16-17E; T37S, R14-15-16-17E; and T38S, R15-16E.

Approximately 5,111 acres of the watershed are within the Gearhart Mountain Wilderness and are managed under the Management Area (MA) 10 (Map #4) Standards and Guidelines within the Fremont National Forest Land and Resource Management Plan (Forest Plan).

The watershed also contains *a* portion of the Coleman Rim Roadless area, which includes approximately 2,363 miles of high elevation mixed conifer, meadows, and rim rock. During the forest planning process, these acres were identified as Roadless Area Review and Evaluation (RARE)II, but were consequently redesignated as MA-5. No road building or timber harvest has occurred since the Forest Plan was adopted. The remainder of the watershed is comprised of the following *MA's,* acreages and management emphasis (Forest Plan):

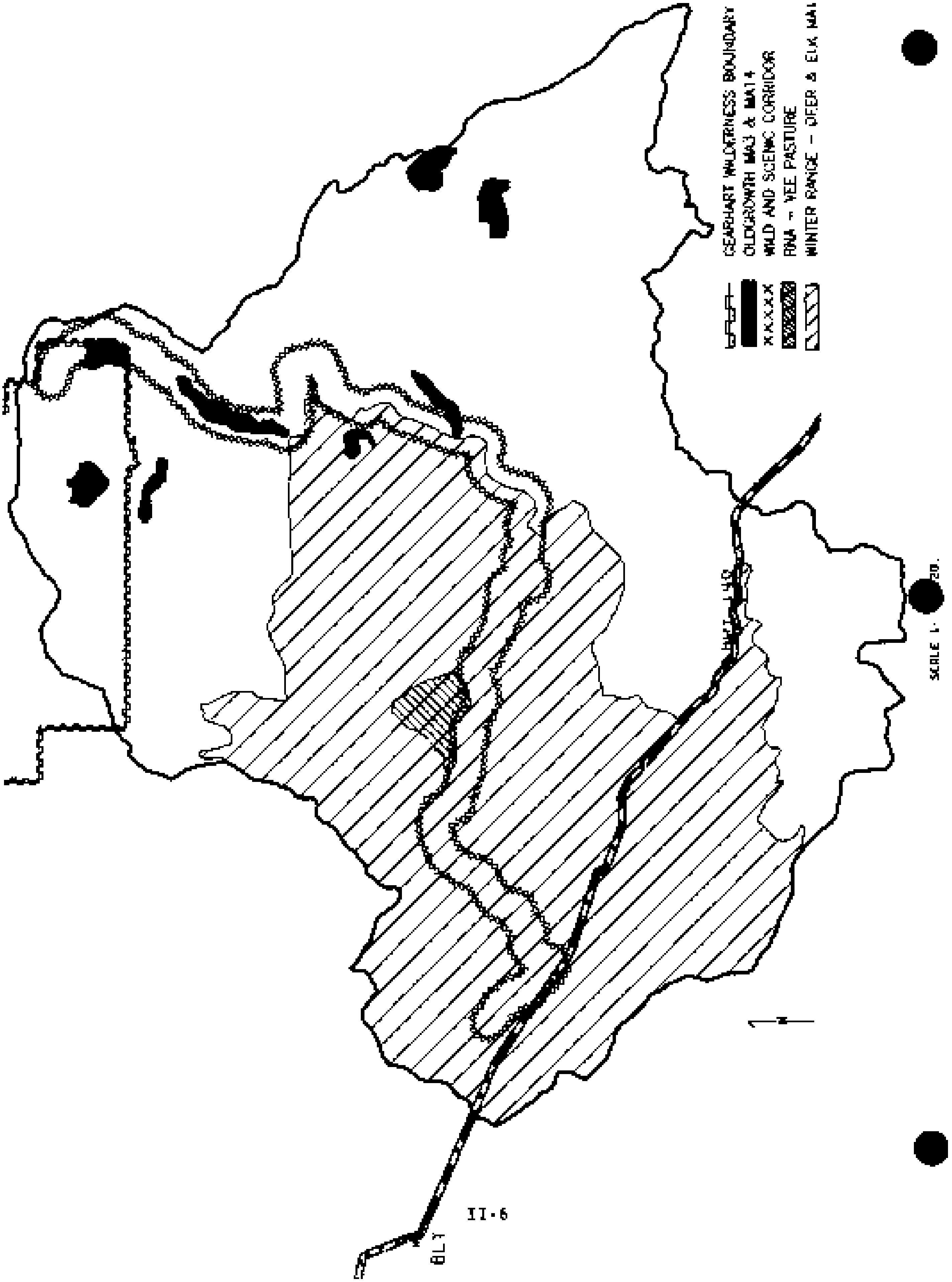
Table 1-Management Areas

MA	Acres*	Emphasis
1	36,648	Mule Deer Forage and Cover on Winter Range
3 & 14	1,097	Old Growth Habitat for Dependent Species (Minimum and Above)
5	11,800	Timber and Range Production
6A	3,060	Scenic Viewshed
7C	9,313	Special Management Areas (Includes South Fork Wild & Scenic, Coleman Roadless and Coleman Wildlife)
8B	617	Research Natural Areas (Proposed Vee Pasture RNA)
15	6,800	Streamside Management
16	10,540	Minimum Management (Non-commercial)

*Due to overlapping acreages within each management area, the combined total of the management areas will not equal the combined total number of federal acres for the watershed as listed in the general description of the watershed area.

SOUTH FORK SPRAGUE WATERSHED

MANAGEMENT AREAS



2. Geology and Soils

The underlying bedrock is, for the most part, the parent material for the soils present. The dominant soil types (37%) are silty clay, silty loam and clay loam derived from basalt, andesite and tuff. The rock mineral composition, resistance to weathering, and age dictate the amount and type of soil that develops. The very stony scabrock flats are silty clay-clay soils and comprise nearly 23% in discrete mapping units and are minor inclusions within other mapping units, suggesting that more than 25% of the area is of this soil type. (Soil Resources Inventory (SRI), Fremont National Forest, Pacific Northwest Region, 1979)

The analysis area is dominated by extrusive igneous rock (85%), of which, olivine basalt from the Tertiary geologic period is the most common type (46%). Of the remaining area (15%), rhyolite and rhyolitic tuff are the most common. The remainder is either Quaternary alluvial deposits on the river valley floor, or Quaternary pediment and fluvio-glacial gravels at the head of Brownsworth Creek. There are also intermediate intrusive rocks on Gearhart Mountain and at the head of Whitworth Creek on Coleman Rim.

Basalt, andesite, and tuff-derived soils that have been overlain with shallow to moderately deep volcanic ash from Mt. Mazama comprise nearly 30% of the area. Basalt and andesite are the hardest rocks present and decompose slowest, followed by rhyolite, then tuff.

In addition, Mt. Mazama ash and pumice were deposited from the eruption plume onto the previously developed soils. The ash and pumice were then relocated by wind and water to various depths, and were often mixed by burrowing animals and such events as windthrown tree roots. Due to the coarser texture of ash and partial mixing, these soils are typically loamy sands over stony clay loams.

The amount of clay in soils greatly influences soil properties and behavior, and are a function of the clay-forming minerals in the parent material. Rhyolite contains a high percentage of quartz, therefore, rhyolitic soils are sandy loams (7.5%). Those rhyolitic residual soils overlain with Mt. Mazama ash are loamy sands over sandy loams (11.5%).

Pyroclastic soils occur on 10.5% of the area and are fine textured clay loams to silty clays. Alluvial soils (3%) are also fine textured (silty clay loams). With the exception of the pyroclastic and alluvial soils, all soils tend to be gravelly to stony.

3. Climate

The general area is located in the semiarid rain shadow east of the Cascade Mountains. Most precipitation comes during the fall, winter and spring months and is snow-dominated. Although summers are dry, they are characterized by intense localized thunderstorms. Average annual precipitation varies by elevation and ranges from about 12 inches in the river valley to over 30 inches on Gearhart Mountain. The 24 hour 25 year precipitation intensity, according to the National Oceanographic and Atmospheric Agency (NOAA-Atlas 2), ranges between 2.40 and 2.80 inches.

The Town of Lakeview (the closet weather station) is about 30 miles east-southeast of the center of the South Fork Sprague River watershed. The precipitation varies from 5.81 to 26.03 inches. A review of the monthly precipitation records taken in Lakeview, Oregon, suggests that, although the average precipitation from 1924 through 1994 is 14.66 inches, there is no normal annual precipitation amount. Only five percent of the years were average (14.00-14.49 inches) while 15.50-15.99 inches, 16.00-16.49 inches, 17.00-17.49 inches and 18.00-18.49 inches each occurred five percent of the time also. The most common amount, 11.00-11.49 inches, occurred ten percent of the time. The remainder of the years were variable.

Temperatures also vary widely, both seasonally and by elevation. Summer highs are 100°F in the valley bottoms with temperatures reaching 90°F in the higher elevations, and winter lows are well below 0°F at both elevations. Freezing temperatures can occur any time of the year, especially in cold air basins and at the highest elevations.

Higher elevation areas have a progressively shorter growing season; the growing season is significantly shorter over 6,500 feet elevation where ponderosa pine becomes less common.

4. Vegetation

Upland: The vegetation in the area is variable, because of the high variation in elevation (4,340 to 8,370 feet), annual precipitation (12 to 30+ inches), length of growing season, soil texture, soil depth and aspect. Natural events (such as insect infestations and wildfires) and historic management activities (including fire suppression, cattle grazing and timber harvest) add to variability. At least one quarter of the area is scabrock flats which generally support grasses, sagebrush and juniper. Less than 3% of the area is riparian zones/meadows supporting a variety of forbs, grasses, and sedges, along with willow, alder, aspen and/or cottonwood.

The dominant vegetation type is commercial forestland occupied by ponderosa pine, lodgepole pine, and/or mixed conifer stands that include ponderosa pine, lodgepole pine, sugar pine, western white pine, white fir and/or incense cedar. With the exception of the Gearhart Mountain Wilderness and inaccessible areas such as canyonlands, natural conditions on commerical forestland has been altered by timber harvest, suppression of wildfires, drought-related mortality and uncontrolled wildfires. Areas planted following clearcutting or wildfires are typically monocultures of ponderosa pine or lodgepole pine where mixed conifer stands once stood.

Riparian: The riparian within the area buffers the fluvial system from the potential impacts of disturbances caused by direct management activities, natural events and upland management activities. Included within the riparian area is a well-vegetated zone with grasses, sedges, forbs, shrubs and/or trees. The above-ground biomass adds to the coarseness of the surface and disipates floodwater energy, and acts as a filter to catch and hold sediment before it can reach the stream. The below-ground biomass holds the soil together and minimizing banks eroding into the stream.

A historic riparian area that no longer has a functioning floodplain due to channel downcutting will lose those attributes that constitute a functional riparian area. The soils, which are in close proximity to the stream and tend to be fine textured, are subject to erosion and contribute to the sediment load of the stream.

Few examples of pristine riparian areas exist within the watershed due to historic grazing practices. Through more than 100 years of intense grazing pressure of the riparian areas, cattle have modified species composition. Cattle within the area browse riparian shrubs and tree seedlings, reduce soil productivity through compaction, nutrient export, and lower the water table indirectly by causing bank erosion and channel downcutting.

5. Fluvial System

The South Fork Sprague River watershed can be divided into four subwatersheds (subsheds-see map #2). The following is a breakdown of those subsheds and acreages:

Subshed A-(Brownsworth-12,890 acres 5,310 acres Forest Service, 7,580 acres Private) includes Brownsworth Creek and its tributaries Hammond Creek, Leonard Creek, and Long Creek. Long Creek flows into a canal that diverts streamflow to Campbell Reservoir which is outside the analysis area. Brownsworth Creek flows into the South Fork Sprague River, northwest of Round Butte.

Subshed B-(Upper South Fork Sprague-16,180 acres 14,390 acres Forest Service, 1,790 acres Private) is the upper South Fork Sprague River, and its tributaries (Camp, Corral, Jack, Jade, Buckboard and Alder Creeks) to its confluence with Whitworth Creek.

Subshed C-(Pothole/Whitworth-14,480 acres 6,894 acres Forest Service, 7,586 acres Private) includes Whitworth Creek, its unnamed tributaries and Pothole Creek.

Subshed Z-(Lower South Fork Sprague-38,550 acres 16,627 acres Forest Service, 21,923 acres Private) is the lower South Fork Sprague River from the confluence with Whitworth Creek to its confluence with Paradise Creek. The tributaries within this subshed are Ish Tish, Indigo, Badger and Paradise Creeks.

The Forest Service manages 53% of the watershed. Ownership by subshed is broken down as follows: The Forest Service manages 41% of Subshed A, 89% of subshed B, 48% of subshed C and 43% of subshed Z. Weyerhaeuser Company is the majority landowner in subsheds A, C and Z. Of the total miles of perennial streams in the watershed, 37% are located on Forest Service managed lands. The notable exception is the upper portion of the South Fork Sprague River, Subshed B, where 87% of the perennial streams flow through Forest Service managed lands.

6. Insects and Disease

The roles of insects and diseases as disturbance agents in the forest are very closely tied to vegetation patterns. Factors such as species composition, size structure, and density of forest stands are all very important in determining which agents are likely to be operating in the forested environment, their abundance, and how profound their effect is likely to be on that vegetation. By their actions, insects and diseases sometimes alter the very vegetative patterns that provided them with suitable habitat, and set the stage for new processes to occur.

Tree growth and vigor, as influenced by site conditions, also play a very important part in determining when and where insect and disease organisms will be operating.

The combinations of site characteristics, growing conditions, and vegetative patterns often allow us to predict changes that are likely to occur due to the actions of insects and diseases. By the *same* token, a recent history of insect and disease infestations would also imply that certain vegetative patterns were present on the landscape when these disturbance agents were at work. For example, the extremely high levels of fir engraver activity across the Fremont National Forest during the early 1990s reflected high stocking levels of white fir in fire-climax ponderosa pine sites. Similarly, high incidence of annosus root disease in many ponderosa pine stands suggests low-productivity sites combined with *a* cutting history that has produced many large stumps to be inoculated by the fungus.

The key to keeping these insect and disease disturbance agents operating at natural or acceptable levels involves managing the vegetation patterns across the landscape. The degree to which a forest is healthy can be measured by the overabundance or absence of the various combinations of size, structure, and species composition that can occur within a particular vegetation series or ecoclass. The desired vegetative condition, then, from a forest health perspective, would be one where all possible combinations of size, structure, and species composition are represented in a balanced distribution across the landscape. This type of vegetative assemblage conveys a resilience to the forest and limits the scale at which disturbance agents operate. Furthermore, it provides "replacements" for those components which are temporarily lost due to perturbations in the system.

7. Settlement

Human occupation of the watershed began in prehistory and carries through into the recent historic era. Prehistory *is* defined *as* the time prior to pioneer exploration and settlement of the watershed; the historical period begins with recorded pioneer exploration and settlement. The human use of the watershed has likely changed in nature and intensity over time. The watershed appears to have been the focus of seasonal use by Native American Indian tribes, as a major travel route for early settlement, and in more recent times, for management activities such *as* logging and grazing.

Prehistory: Due to the high elevation, Native American Indian tribes used the watershed seasonally. The Quartz pass area (southeastern portion of the watershed) was a central gathering place for the Klamath, Northern Paiute and the Modoc tribes primarily in the summer months from May through July. Generally, the Klamath tribes came from the Sprague River Valley to the West, the Northern Paiute from the east and the Modoc tribes from the south. The tribes would congregate for trading, gathering roots and berries, obtaining obsidian sources, and possibly fish and game curing. Important native berry plants included currant, elderberry, and wild plum and root plants such as camus, balsom root, and epods. Although the history of the Klamath and Modoc tribes is one of almost constant war, the Quartz pass area was probably used for communal gathering and trading.

History: Historic era activities within the watershed began with the construction of the Central Oregon Military Wagon Road (Military Road). The Military Road provided a route for immigrant travel and for potential military needs. The road was financed by businessmen and investors from Eugene Oregon, anxious to increase settlement of southern Oregon as well as to receive 3 sections of land for every mile of road constructed. The military road was surveyed in 1865 by Lieutenant McCall and was completed in 1867. Construction of the road included clearing a route by removing dirt and loose rocks down to the bedrock. The military road was used for 50 years before being abandoned.

The Klamath Indian reservation was established in 1898. The reservation boundary included the western portion of the watershed. The boundary followed the ridgelines along Horsefly Mountain, Round Butte, South Fork Sprague Canyon, Elder Spring, Grouse Prairie, a ridge north on Leonard Creek to the Dome and the Notch on Gearhart Mountain. The reservation boundary was later moved to the west, outside the watershed in 1954.

Pioneer exploration and settlement followed the construction of the military road and the establishment of the reservation. Homesteading generally began in the early 1900s. Pioneer ranching families such as the Utleys, Hydes, Obenchains and Rentles, settled in the southwestern portion of the watershed. The Rentles settled near Ish Tish Creek, now the Baio Ranch, and the Obenchains and Hydes at ranch sites along the South Fork River.

The Ewauna Box Company constructed the first railroad lines in 1929 from Bly to Quartz Mountain pass. At the pass, spur lines were constructed to access timber stands. Ewauna Camp, located east of the watershed boundary, was the hub of the logging activity. The camp and associated rail lines were in use approximately 10 years. In addition to timber, the rail lines were also used to transport sheep and cattle. A paved route between Bly and Lakeview was constructed in 1930. This highway has since been rerouted, but basically followed the current path of Highway 140.

A recent trend of settlement has been subdividing the large original ranches and the purchase of investment property. For example, the area near the original Utley cabin is now under several different ownerships. However, few new cabins or vacation homes have been built. Future demand may increase for vacation homes, investment properties and alternative home sites.

B. Beneficial Uses

1. Aesthetic and Scenic

The watershed contains high aesthetic quality scenery. Among the outstanding aesthetic features *is* the feeling of solitude forest visitors can achieve, particularly within the Gearhart Mountain Wilderness. Other places where solitude *is* possible include the headwaters of Long, Brownsworth and Leonard Creeks, the South Fork Canyon, the high elevation meadows, and rim rock and roadless areas of Coleman Rim. Solitude will continue to be a highly demanded beneficial use within the watershed.

Scenery within the watershed is generally of high quality. The watershed is visible from the town of Bly and provides foreground views for Highway 140. Within the watershed, 2,979 acres are managed as MA6 retention, and 82 acres as MA5 partial retention. Corridors managed for scenic quality include Highway 140 near the Sprague River Picnic Area, Highway 140 from the Baio Ranch to Quartz Mountain, and road 34 from Brownsworth Creek to Lookout Rock. The Robinson Spring Burn, 1992, affected the visual quality of the Highway 140 corridor. However, effects were minimized due to the large amount of standing live trees and snag trees left in the immediate foreground. A second portion of the watershed has a modified appearance due to past timber harvest. Clearcuts adjacent to the Gearhart Mountain Wilderness are visible from Highway 140.

Visual quality will continue to be a highly demanded beneficial use. 1993 traffic volume on Highway 140 at the Lake/Klamath County line was 335,800 vehicles. This figure does not differentiate between commercial and recreational use within the visual corridor of Hwy. 140.

Road 34 receives high use because it is an important access route for such recreation sites *as* Mitchell Monument and the Gearhart Mountain Wilderness. Between 1984 and 1985, the road averaged 114 vehicles per day during the season extending from May to December 1994. Approximately 83% of the use was recreational.

2. Agriculture and Grazing

Historic Use:
Few accurate numbers or dates are available for grazing within the watershed prior to 1935 . Grazing is believed to have begun in the 1880s. At that time the entire watershed was under public domain. The _ class of livestock was generally sheep. Complete Forest Service grazing records begin in the 1930s.

Blaisdell: When Forest Service records began in 1936 when approximately 500 head of sheep grazed the allotment from 6/16 to 9/15. In 1937, the class of livestock changed to cattle. From 1937 to 1946, the number of cattle was approximately 260, the season of use was 4/15 to 7/1. In 1947, the permittee changed from James Owen to Vance Hall. Hall grazed only 35 cattle in 1947 from 4/16 to 9/30. The herd was eventually increased to approximately 100 head by 1951.

Also in 1951, an allotment management plan was approved. Since 1950, the amount of grazing has generally remained constant, with 105 cattle using the allotment between 5/1 and 9/30. In 1960, a two pasture deferred rotation system was implemented. There have been six years of non-use in the history of the allotment.

Animal Use: There are no trends in usage. Head months have remained consistent at approximately 500 since 1951. From 1943 to 1951, head months fluctuated between 190 and 340. The years of heaviest cattle use occurred between 1937 and 1942, numbers peaked at 910 head months.

Swede/Deming (Swede Cabin Pasture): Forest Service records begin in 1936, approximately 306 cattle grazed the allotment from 4/15 to 6/15. Since 1936, the class of livestock has been cattle. Cattle numbers have fluctuated. From 1936 to 1947, W.R. and Dave Campbell ran between 280 and 400 cattle. The permitted season of use was 4/15 to 6/15, under on "on-off" type permit. In 1953, an allotment management plan was written and recommended the season of use from 4/1 to 5/15. Beginning in 1963, cattle have not been turned out until May, with the average season of use between 5/10 and 6/25. Between 1950 and the present cattle numbers have fluctuated between 300 and 500. There have been two years of non use in the history of the allotment.

Animal use: There are no trends in usage. Head months have fluctuated between a low of 221 in 1976 and a high of 1182 in 1942. Generally, most years have averaged 550 head months. Periods of high use include an average of 800 head months between 1936 and 1945, 700 head months between 1970 and 1974, and 700 head months in 1982 and again in 1990.

Pothole: Forest Service records begin in 1908. Between 1908 and 1962 the present Pothole allotment was composed of three smaller allotments: Pothole, Drews Creek and Deer Creek. The Deer Creek allotment dates to 1908, when it also was composed of three smaller allotments. Both sheep and cattle used the allotment. The smaller Deer Creek allotments were consolidated in 1929 and approximately 1200 sheep were grazed from 6/16 to 9/15. The Drews Creek allotment was acquired by the Forest Service in 1945 from the Ewauna Box Company. W.H. Leehmann held a permit for approximately 1000 sheep between 1945 and 1961. The season of use was short, only a couple weeks, in either the spring or fall. Records for the Pothole allotment date to 1913. From 1913 to 1924 approximately 2000 sheep grazed the allotment from 6/15 to 10/15. Sheep numbers were reduced in 1930. From 1930 until 1961 approximately 1000 sheep grazed the allotment from 7/1 to 10/15.

All three allotments were combined to form the present Pothole allotment in 1962, and the class of stock changed to cattle. Cattle herd size increased from 130 in 1962 to a high of 920 in 1972. The season of use between 1962 and 1980 was from 7/1 to 9/30. The season of use was extended a month earlier to 6/1 beginning in 1981, and to 5/15 in 1990. In 1994, the allotment was fenced and a three pasture rotation grazing implemented.

Animal Use: (Note: animal numbers have been converted to AUMs to allow comparison between years when different classes of livestock used the allotment.) Records dating back to 1913 allow some trend analysis to be made.

Generally there have been two eras of heavy domestic animal use on the Pothole Allotment. One between 1913 and 1924 and one between 1981 and 1988, and again between 1990 and 1994.

In 1913, approximately 2400 sheep were permitted on the Pothole Allotment from 6/15 to 10/15. No records are available from the Deer Creek or Drews Creek allotments from this year. The earliest numbers available from these allotments occur in the 1940s. At that time, 1200 sheep grazed Deer Creek and 1000 grazed Drews Creek.

By the 1940s, sheep numbers had been cut by approximately 50% on the Pothole allotment. This reduction is consistent with the overall forest reduction in sheep numbers between 1907 and 1940. In order to determine animal numbers on the entire Pothole allotment, two sets of numbers can be extrapolated back to the 1913 period, one conservative and one liberal. Under the liberal assumption that Deer & Drews Creek allotment had twice the amount of animals in 1913 as in 1940, (i.e. similar to Pothole), then animal numbers in 1913 were 2400 sheep from 6/15 to 10/15, 2400 sheep from 6/16 to 9/15 and 2000 sheep from 9/20 to 9/30. Total AUMs were approximately 3700. Under the conservative assumption that Deer & Drews Creek allotments had the same amount of animals in 1993 as in 1940, then animal numbers in 1913 were 1200 sheep from 6/16 to 9/15, 1000 sheep from 9/20 to 9/30 and 2400 sheep from 6/15 to 10/15. Total AUMs were approximately 2800.

Records between 1945 and 1961 are complete. During this period approximately 1000 sheep grazed the Deer Creek Allotment between 6/16 and 9/15, 1000 sheep grazed Drews Creek Allotment between 6/16 and 6/30 and 1000 grazed Pothole between 7/1 and 10/15. Total AUMs were approximately 1600.

During the period 1962 through 1968 when cattle used the allotment, the herd increased in size from 130 to 700. Season of use was 7/1 to 9/30.

Between 1968 and 1980 the cattle herd fluctuated in size between a low of 356 in 1979 and a high of 920 in 1970. Average herd size was approximately 700 and the season of use from 7/1 to 9/30. AUMs were approximately 2500.

Between 1980 and 1988 the cattle herd fluctuated in size between a low of 702 and a high of 750. Average herd size was approximately 730 and the season extended from 6/1 to to 10/1. AUMs were approximately 3500.

Between 1990 and 1994 cattle herd size was reduced between a low of 486 and a high of 600. Average herd size was approximately 600 and the season use extended from 5/15 to 10/15. AUMs were approximately 3600.

Other Allotments: Analysis or trends of other allotments, within the watershed have not been made because the watershed overlaps with only a small portion.

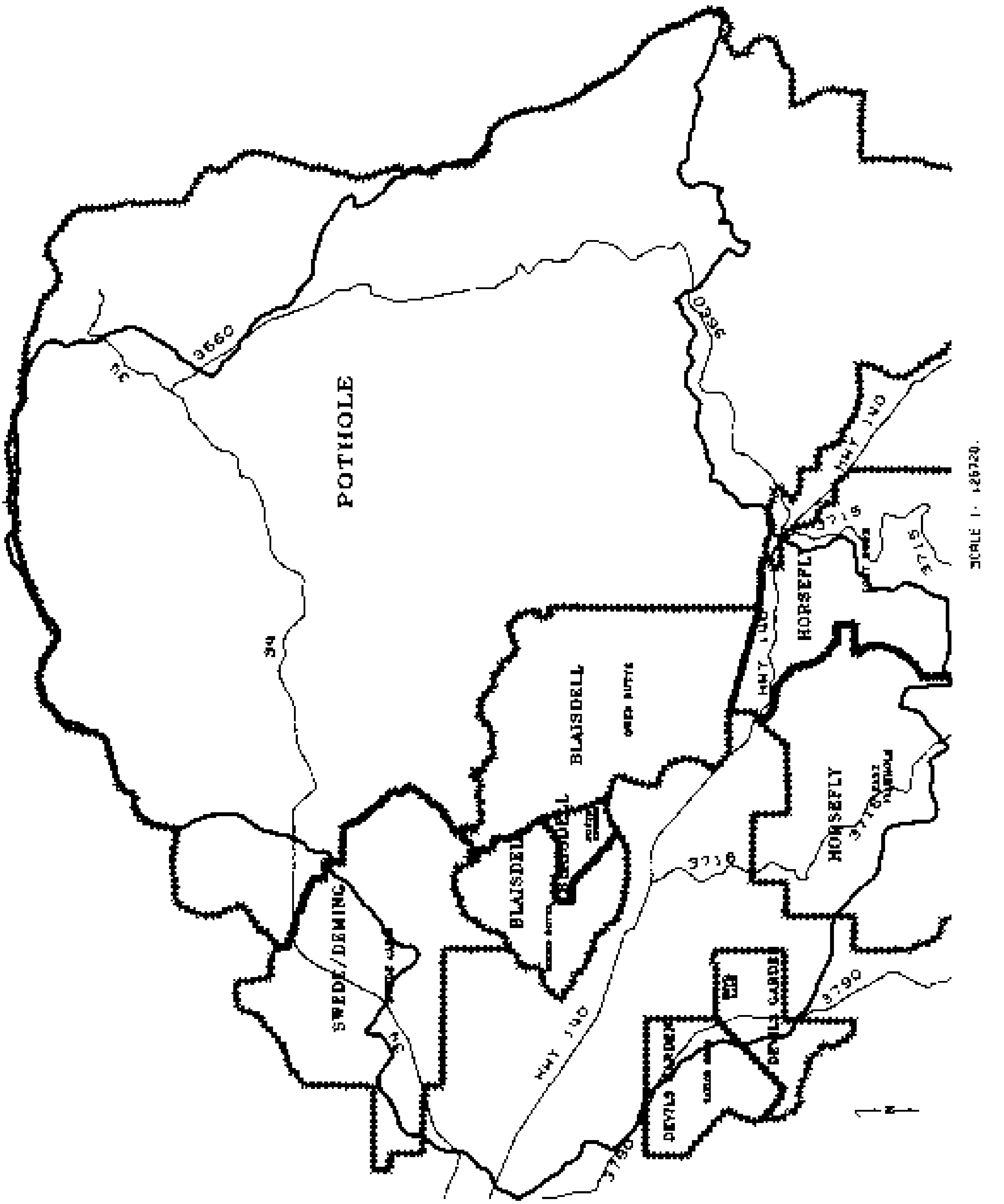
CURRENT USE

The watershed contains portions of the Blaisdell, Dairy Creek, Deming Creek, Devil's Garden, Horsefly, Pothole and Swede allotments (see range allotment map #5). The current use for these allotments is summarized below.

MAP #5

SOUTH FORK SPRAGUE WATERSHED

RANGE ALLOTMENT BOUNDARIES



ALLOTMENT/PASTURE	ACRES	PERMITTEE	PERMITTED #'s	SEASON
Blaisdell		Baio	84	5/1-9/30
Owen Butte	6324			
Round Butte	2277			
Butte Spring	517			
Dairy Creek	71	Berry	296	7/1-9/15
Deming Creek	4	Vacant		
Devils Garden		Vacant	300	5/1-5/15
Taylor Draw	488			
Devil Lake	828			
Horsefly		Newman/	1156	6/1-9/30
East Fishole	4795	Hainsville		
Lost Burn	2649			
Pothole	49398	Sparrowk	600	5/15-9/30
Swede		Rocking AC		5/1-5/31
Swede Cabin	3384		581	

3. Biodiversity

Biodiversity is described in the existing and desired condition for this report. The demand for this beneficial use is expected to greatly increase in the near future. Increases in demand can be expected for old growth areas, and diverse habitats for flora and fauna as private lands, both within the watershed and adjacent to NFS lands, are used for resource extraction and development.

4. Cultural Resources and Archaeology

Evidence of human occupation in the watershed during the prehistory period includes two petroglyph sites, pictograph sites along Coleman Rim and many lithic scatters in the Quartz Pass area. Sources of obsidian were probably obtained in nearby Drews Valley. The obsidian was traded and shaped into tools within the watershed. Other archaeological sites in the watershed include Pothole Creek and Coleman Rim where scrapers and knives have been found. The watershed was probably used for religious activities, but no evidence of vision quests sites have been located. The general topography of the area affords views of the surrounding landscape and contains important high peaks such as the dome on Gearhart Mountain and other prominent geologic viewpoints.

Evidence of historic era activities begins with the Military Road. Within the watershed, a three-mile section of the road can be seen near Quartz pass. The oldest structure in the watershed is the remains of cabin which dates to 1909. It is located near the current 7C ranch, where the South Fork River leaves the watershed. This structure was owned by Gustav Darrow, a pioneer homesteader. Most of the older structures in the watershed are line shacks, built for overnight stays by cowboys along cattle and sheep stock routes. Examples can be found at Swede Cabin, Utley Cabin, Mitten Springs, and a historic corral at Finley.

Railroad grades from the Ewauna Box Company can be seen in the southeastern portion of the watershed at Quartz Mountain, in the Robinson Spring burn area, and on Weyerhauser property along Whitworth Creek. Many of the grades are currently being used as forest access roads.

5. Mining

There are no current or historic mining activities or claims within the watershed. A portion of the watershed, near Quartz Mountain, was surveyed in the 1980s for gold. Historic mining of gold and cinnabar have occurred outside the watershed at Quartz Mountain, Quartz Butte and south of Buckhorn Springs.

6. Recreation

The watershed provides opportunities for diverse recreation experiences including hunting, fishing, trapping, camping, photography, hiking and backpacking, horseback riding, skiing, snowmobiling, mushroom and native plant collection.

Fishing and hunting activities bring the most visitors to the watershed. Elk, mule deer, antelope and bear are the primary game species. Upland birds, waterfowl and small game are also hunted. The watershed *lies* within the Interstate hunting unit, a popular choice among Oregon hunters. The table below illustrates hunter *use* in the Interstate hunt unit.

Hunt	Applicants	Tags/Hunters	Hunter Days
Elk (Controlled hunt)	219	100	
Elk (Archery)		45	
Elk (General hunt)		171	
Elk (Total)			1563
Deer (Controlled hunt)	2344	500	
Deer (General/archery)		635	
Deer (Total)			3718
Antelope (Controlled)	364	60	635
Bear (general)		59	949
TOTAL	2927	1570	6865

Anglers fish for redband, brown and brook trout in popular creeks such as Leonard, Brownsworth and the main stem of the South Fork Sprague. High use fishing takes place at the Sprague River picnic area and near Corral Creek campground. The South Fork Sprague River offers some of the best fishing on the Bly Ranger District. Dispersed campsites occur along many of the perennial streams in the watershed.

TRAILS & CAMPGROUNDS

The watershed includes approximately three miles of designated hiking trail from Lookout Rock into the Gearhart Mountain Wilderness. Although undesignated, other popular routes occur along Coleman Rim, in the South Fork Canyon, at the Sprague River Park.

An opportunity for winter recreation activities occurs near Quartz Mountain. The pass is a designated State of Oregon Snopark, with parking available for approximately 10 vehicles with trailers. The District has designated approximately 6 miles of cross country ski trail within the watershed and approximately 12 miles of snowmobile route. The snowmobile route proceeds from Quartz Snopark north along road 3660 to road 34. In 1994, approximately 4500 visitors used the Quartz Snopark. This figure does not differentiate between snowmobile and cross country users, or those who used the Snowpark and recreated outside the watershed.

Developed campsites include the forest camp at Corral Creek and a picnic area at the Sprague River Park. Fishing and access to Gearhart Wilderness Mountain make Corral Creek a popular campsite. In 1994, it received 5000 visits. Other popular dispersed campsites occur at Finley Corrals, Jack Flat, Coleman Rim, Lantern Flat, Bare Flat and Camp Creek. The day use Sprague River Picnic area receives approximately 27,000 visits per year.

7. Research Natural Area

VEE PASTURE

The Vee Pasture is a 620 acre proposed research natural area. It is located in the notch of Forest Service land which lies south of Brownsworth Creek and north of the South Fork Sprague River. The area was designated an RNA because it fills two cells needs (or elements) in the Eastslope Oregon Cascades Physiographic Province of: 1) #5-Western juniper (Juniperus Occidentalis)/low sagebrush (Artemisia arbuscula)/Idaho fescue (Fescuca idahoensis) and bluebunch wheatgrass (Agropyron spicatum) communities and 2) #47-Low sagebrush (Artemisia arbuscula) vegetation complex, with Idaho fescue (Fescuca idahoensis), bluegrass (Pao sandberg) and bluebunch wheatgrass (Agropyron spicatum).

The RNA will provide a reference area for comparing results from the effects of resource management techniques and practices outside the RNA, opportunities for on-site and extension educational activities, and a reserve for the preservation and maintenance of genetic diversity and biodiversity as a whole.

8. Roads and Access

An 11-mile stretch of Oregon State Highway 140 is the main access route through the watershed. Highway 140 intersects important Forest Service access routes, including the Fishhole Creek Road (3790), the 34 road, the 015 road, and the Boys Ranch Road (3716). In addition, the Quartz Mountain Snopark accesses the Lofton Road (3715) and road 3660. These routes provide access for private interests, such as Aspen Ridge Resort and permanent residences along the Boys Ranch road, as well as recreational access to the Gearhart Wilderness Mountain, Mitchell Monument, the Quartz winter recreation area and the Fishhole Lakes recreation area. Road access is presently adequate in the watershed. Demand for greater access is not expected to increase.

Table 1. LAND OWNERSHIP (in Miles^2)

Subshed	FS	NON-FS	Total
A	8.294	11.839	20.133
B	22.479	2.797	25.276
C	10.772	11.854	22.626
Z	25.855	34.379	60.234
TOTAL	67.400	60.869	128.269

Table 2. ROAD DENSITY

Subshed	Miles	FS Density	Miles	NON-FS Density	Miles	Total Density
A	31.1	3.761	26.43	2.232	57.62	2.862
B	94.5	4.206	12.98	4.641	107.52	4.254
C	57.6	5.353	33.61	2.835	91.27	4.034
Z	82.7	3.200	51.73	1.505	134.46	2.232
TOTAL	266.12	3.948	124.75	2.049	390.87	3.047

* All acreage figures supplied from land ownership layer in GIS

** All road miles calculated from TSU layer in GIS

*** The TSU road layer map was reviewed by Bly engineering, summer 1994. Forest Service road locations and miles were determined to be correct. The mileage of non-FS roads reported is low. The TSU layer only contains major routes across private lands within the watershed. For example, the TSU layer contains few "surface-level type 'D' roads", or logging roads on private land. As such, the road densities for non-FS lands are actually higher. Therefore, the total watershed road density is also higher.

9. Special Uses

The watershed contains two permanent meteorological stations, one located adjacent to the Quartz Snopark, the other at Corral Creek. These sites are administered by the U.S. Meteorological Agency.

A special use power line is located approximately 1/4 mile north of Hwy. 140. This 100 foot corridor is under special use permit to Pacific Power & Light.

A special use permitted telephone line is located approximately 1/4 mile south of Hwy. 140. administered by U.S. West.

10. Timber

Timber harvest has been a beneficial use since the 1930s. Large portions of the watershed have been entered each decade. By 1990, the only forested portions of the watershed that had not been logged include the Gearhart Mountain Wilderness, the South Fork of the Sprague Canyon, and approximately 700 acres along the Coleman Rim. Timber volumes produced from the watershed vary by decade. Total volume produced in the watershed since 1929 is approximately 316 mmbf. This amount does not include volume produced from private lands between 1950 and 1994. Timber harvest by decade is summarized below.

1930s: Significant commercial timber harvest in the SFS watershed began in the 1930s with the advent of railroad logging. The Ewauna Box Company purchased the Quartz Mountain timber tract from the Booth Kelly Lumber Company in 1928. The tract of land was approximately 30,000 acres with a possible yield of 300 mmbf. Approximately 14,000 acres are within the watershed. Rail construction began in 1929 and continued through 1931. The main haul route was constructed from Bly to Owen Butte and then to the Quartz Mountain pass. At the pass, approximately 75 miles of rail were constructed.

Logging began in 1931, reaching a peak of 250 mbf/day in 1935. By 1936, the Quartz Mountain tract was cut out. The company had logged some adjacent ranch land, and some timber owned by the Pelican Bay Lumber Company as well as their own holdings. The life of the system was just eight years.

ACRES First Entry: 14,000
ACRES Re-entry: None
Volume Harvested: 140 mmbf
Significant Events: Railroad logging by Ewauna Box Co., small logging operations on private ranch land.

1940s: Few commercial timber harvests occurred in the 1940s. The only recorded timber sale in the watershed was the Whiskey Spring sale, located near Deming Creek, in 1947-1948. Active presale work began on other sales within the watershed in the mid to late 1940s.

ACRES First Entry: 800
ACRES Re-entry: None
Volume Harvested: Not available
Significant Events: Presale work began for sales on National Forest lands, 1947 to 1949.

1950s: Commercial operations on National Forest lands began in the 1950s. Commercial sales on small private land holdings also began. Large amounts of slash were created for the first time, such as in timber *sales* near Deming Creek and Round Butte. Slash is partly responsible for carrying subsequent fires in 1955. During the 1950s, the Forest Service became responsible for "releasing" timber *sales after* adequate slash fuel reductions. Records are available for treatments on both private and public lands through the 1970s.

Acres First Entry: 8,000
Acres Re-entry: 1,200
Volume Harvested: Forest Service: 30 mmbf; Private: unavailable.
Significant Events: Large first entries into Forest Service lands along Pothole Creek. Light entries into Round Butte and Deming Creek area followed by large salvage harvests following fires. Active logging activity on small tracts of private lands, specifically pine types on ranch lands in subshed "Z."

1960s: Commercial operations on Weyerhauser lands generally began in the 1960s. Large blocks of private land were entered for the first time. Remote Forest Service parcels, such as along Coleman Rim, Grouse Prairie, and areas south of the Gearhart Mountain Wilderness were also entered. These sales were generally large overstory removals. For example, Modoc Lumber Company removed approximately 19 mmbf from the Buckboard Creek area between 1966 and 1969. Some areas railroad logged in the 1930s were re-entered.

Acres First Entry: 15,000
Acres Re-Entry: 5,000
Volume Harvested: Forest Service: 78 mmbf; Private: unavailable.
Significant Events: Large overstory removals on both public and private lands. Some stands re-entered with silvicultural prescriptions to move the stands in a managed direction.

1970s: Commercial operations on both private and public lands consisted of salvage removal of previously logged stands, and timber removal based on stand prescriptions. Large Forest Service timber sales included Box, Long Draw and Mit.

Acres First Entry: 1,000
Acres Re-Entry: Forest Service: 4,800; Private: unavailable.
Volume Harvested: Forest Service: 24 mmbf; Private: unavailable.
Significant Events: Last areas of 'virgin timber' logged east of the Gearhart and along Leonard Creek and Mitten Spring.

1980s: Commercial activities included large timber sales such as Jade Watt, Mix, Whit, Best, Finley II, Lantern and Leonard. Some of these sales were prepared in response to section 318, which accelerated timber harvest on eastside forests. Small sales and stand improvement sales were also common during this period.

Acres First Entry: 200
Acres Re-Entry: Forest Service: 8,000; Private: unavailable.
Volume Harvested: Forest Service: 50 mmbf; Private: unavailable.
Significant Events: Large timber sales as a result of section 318, second entry logging in Camp Creek, Mitten Spring, Jack Flat & Buckboard Creek areas. Small sales and stand improvement sales were also common

1990s: Commercial activities included large salvage sales *as a* result of the Robinson Spring Fire, 1992. No green tree sales have been planned or harvested.

Acres First Entry: none
Acres Re-Entry: Forest Service 5000; Private: unavailable.
Volume Harvested: 18 mmbf; Private: unavailable.
Significant Events: Large salvage sales as a result of Robinson Fire. Shift to outcome based management, where timber harvest is a result of a management objective and not and end in itself.

11. Water

Water supply supports a multitude of beneficial uses within the watershed, including private domestic water supply, irrigation, livestock watering, dust abatement, salmonid fish rearing, salmonid fish spawning, habitat for resident fish and aquatic life, wildlife, water contact recreation, and aesthetic quality. Demand for this beneficial use is expected to greatly increase in the near future. There are no documented or identified potential uses of water in the watershed for industrial supply, hydropower, or commercial navigation. Increases in demand for all of the above beneficial uses can be expected. In addition, downstream uses of the South Fork Sprague water supply can also be expected to increase.

Existing water claims in the watershed include both ground and surface water rights. The major claims for water are summarized below.

Name	Type/Quantity/Location	Use
7C Ranch	Ground Water/various	irrigation
W.R.Campbell	Reservoir, 1500 AF, Campbell res.	irrigation
Spratt Wells	Surface, unknown, T37S, R15E, S6,	irrigation
James Owen	Surface, various, Ish Tish Creek	irrigation
Louis Perdrian	Surface, various, Paradise Creek	irrigation
Donald Barnet	Surface, 0.5 AF, Paradise Creek	irrigation
Lawrence Little	Surface, 12.7 CFS, unnamed wash	irrigation
May Knott	Surface, various, Badger Creek	irrigation
S.R. Land & Livestock	Reservoir, 850 AF, Fishhole creek	irrigation
J. Watt & F. Griffith	Reservoir, 230 AF, unnamed streams	irrigation
Weyerhauser	Surface & wells, various	roads
Bureau of Land Mgmnt.	Surface, various	stock
USDA Forest Service	Surface & wells, various	roads, stock

Downstream users are also dependent upon the South Fork Sprague watershed supply. The South Fork Sprague river provides an important irrigation source for ranchland between the Sprague River Park and the confluence with the North Fork Sprague River. Key watershed users include the 7C, Campbell, Valladeo, Newman, Hadley, Kearn and Hall ranches .

12. Wild and Scenic River

The South Fork of the Sprague river flows for approximately 24 miles within the watershed. The majority of the river located on public lands was studied in 1994-95 and found to be eligible for inclusion to the Wild and Scenic River system. Portions of the river have been designated *as* recreational, wild and scenic. The resource values identified include recreational opportunities, wildlife and fish habitat, biodiversity and scenery within the canyon. The river corridor, approximately 1/4 mile on both sides of the river, is now under interim management *as a* W&SR until a suitability determination is made.

Beneficial uses of W&SR include preserving the quality and quantity of the free flowing river, maintaining high quality fish and wildlife habitat and providing opportunities for river-orientated recreation.

13. Wilderness and Roadless Areas

On November 11, 1943, the Forest Service established the Gearhart Mountain wild area, and Congress officially designated it as Wilderness under the Wilderness Act of 1964. The watershed contains 5111 acres of the Gearhart Mountain Wilderness. The watershed also contains approximately 2,363 acres of roadless area on Coleman Rim.
Wilderness uses and values include: primitive recreation experience, scientific and educational uses, a benchmark for ecological studies, and the preservation of historical and natural features. The wilderness was first botanically surveyed in the early 1990s, discovering populations of Allium campanulatum (sierra onion), Castilleja chlorotica (green tinged paint brush), and Penstemon glaucinus (blue leaved penstemon). Also in the 1990s, the Forest Service has received three applications for special use permits involving recreation trips into the wilderness using pack animals.

A one-year permit for llama trips was approved in 1993. The most recent proposal, for horse trips, is currently under environmental analysis.

The watershed contains one of the two main access points to the Gearhart Mountain Wilderness, located at Lookout Rock. This access point receives heavy use in the summer because of close proximity to Corral Creek campground. During the summer of 1994, wilderness surveys documented 310 people using this trailhead. There is no estimate available on the number of people who entered the Wilderness without registering.

The Wilderness trail proceeds from the trailhead at Lookout Rock for approximately 5 miles before it leaves the watershed. Before leaving, the trail climbs through the Palisade Rocks and the Dome, two of the *scenic* geologic features visible from Highway 140.

CHAPTER III

ISSUES AND KEY QUESTIONS

III. ISSUES and KEY QUESTIONS

A. Introduction

The core team refined over time and with much discussion, a multitude of issues into the five listed below, in order to provide analysis direction. This was done because of the close relationships of the issues and to focus on major concerns. Issues were developed based on the watershed analysis core team members own knowledge and interviews with others interested or knowledgeable about the area (key contacts). Each issue is complex, and addressed specifically by answering the key questions and the parameters listed with the issue.

B. **Issues**, Key Questions and Parameters

Issue #1: Past management practices such as logging, grazing, road building, etc., have altered water quality within the watershed.

Key questions

1. Does the South Fork Sprague River and it's associated tributaries meet State of Oregon and Forest Plan water quality standards?

   Parameters: temperature and turbidity.

2. Where have management activities resulted in degraded water quality within the South Fork Sprague River (such *as* temperature and turbidity)?

   Parameters: Bank stability, percent stream shading, sediment delivery, macroinvertebrates, and erosion.

Issue #2: Functions in the riparian ecosystems within the South Fork Sprague River watershed have been altered from their assumed historic condition.

Key questions

1. How do land management activities affect riparian ecosystems. Are these activities preventing recovery where these ecosystems are currently not functioning properly?

   Parameters: bank stability, channel morphology, soil condition, soil drainage/lowering of the water table, large woody debris and vegetative community.

2. How have changes in riparian ecosystems affected other resources such as fish and wildlife habitat and downstream irrigation needs?

   Parameters: pools, temperature, base flows, and water quantity (temperature and turbidity).

Issue *3: Base flow, peak flow, and timing of peak flow have been altered.

Key questions

1. Has the natural drainage regime in the watershed been altered by grazing, timber management, road building, and diversion activities?

Parameters: timing and frequency of peak flows and base flow, cumulative effects, soil moisture storage, soil drainage, and current disturbances.

Issue *4: Management activities have modified aquatic/fish habitat conditions and caused changes in TES Species (redband trout, bull trout, shortnose/Lost River Klamath large scale sucker, and Chinook salmon) distribution and populations.

Key questions

1. Have aquatic/fish habitat abundance and conditions, and aquatic system processes and flows been altered?

Parameters: past and present conditions and connectivity; fish composition, distribution, and populations; and location of key refugia or hotspot habitat for TES species.

2. Have management activities affected aquatic/fish biodiversity, community, composition, and distribution, and populations; especially fragmentation of fish species populations, which threatens species viability?

Parameters: large woody debris, pool habitat, bank stability, streamside cover and substrata composition, bank width to depth ratios, fish species composition, distribution and populations.

3. Where are the known problem areas that are contributing to reduced fish habitat capability?

Parameters: location of management activities and natural events affecting fish habitat.

Issue #5: Past management activities in combination with natural disturbances have altered the function, pattern, composition, structure, the amount of vegetation and abundance, distribution and condition of wildlife habitat and populations within the South Fork Sprague River watershed.

Key questions

1. How have landscape patterns, composition, and structure changed over time?

Parameters: past and present landscape metrics (pattern analysis), size, structure, TES species, noxious weeds, roads, and composition of the vegetation.

Harvest will be limited to treatments which enhance other resource values or accomplish specific management objectives. In some portions of the watershed, these objectives would include treatments designed to restore a balance in vegetative structures where a particular condition is over or under represented. Early and mid-seral stands will continue to be managed for maximum growth.

Road densities will be reduced to meet Forest Plan Standards and Guidelines.

Fire suppression will continue. Fire occurrence will continue to be 0.07 to 0.08 fires per year per thousand acres. Fire starts other than the prescribed burning will be of natural origin. Wildfire will be controlled within management direction that applies to the situation at hand. Mechanical means to mimic fire will be used in plant communities that are fire intolerant species. Fire suppression and prescribed underburning as presently practiced will continue on all lands.

Livestock numbers, kind and class, season of use and grazing systems will continue as is presently implemented. Adjustments in season of use and grazing systems may be made as determined by range monitoring and necessity.

Deer numbers and use on winter range will remain stable or slightly increase.

Channel conditions will remain static in the short term and slowly improve in the long term. Previously logged or burned riparian areas will slowly be restocked with shade-providing vegetation.

Large Woody Debris (LWD) recruitment will continue to be present in low • levels and continue to be recruited in low numbers from the remaining riparian trees. Stream bank stability, width to depth, and stream shading will improve only if livestock distribution is controlled more effectively than in the past. Measurable change in Bull trout habitat (Leonard and Brownsworth Creek) will only occur if the riparian areas are rested from grazing for a period of several years and the headwater, native surface roads are obliterated and revegetated (Bull trout conservation strategy).

CHAPTER IV

ANALYSIS OF THE ISSUES

IV. ANALYSIS OF ISSUES

ISSUE #1: Past management practices such as logging, grazing and road building have altered water quality within the South Fork Sprague River watershed.

Key questions

1. Does the South Fork Sprague River (SF Sprague) and it's associated tributaries meet State of Oregon and Forest Plan water quality standards?

   Parameters: temperature and turbidity.

2. Where have management activities resulted in degraded water quality within the SF Sprague (such as temperature and turbidity)?

   Parameters: location in subbasins and/or major stream reaches where water quality problems exist, bank stability, large woody debris, percent stream shading, sediment delivery, macroinvertebrates, and erosion.

Introduction

The interaction between hydrologic processes and watershed components (including geology, soils, and vegetative cover) is very complex and resource management activities contribute further complexity. Surface soil erosion, mass wasting and channel scour are all naturally occurring processes that are accelerated by surface disturbance, removal of soil anchoring vegetation, and concentration of water caused by management activities. Appendix WATER-1 discusses the interactions between land management activities and water quality in general as well as basic hydrologic principles (all referenced maps and water quality charts in this section can be found in the appendix of this document).

For management purposes the watershed is divided into five subsheds. These are described in the Introduction under Fluvial Systems and will be referenced in the following tables and discusions.

Topography in the watershed consists mainly (71%) of gentle slopes (0-15%). Approximately three percent of the watershed has slopes over 35%. The watershed generally faces south and west.

Table WQ-2
Major Topographic Characteristics

Subshed	Length (Mi)	Width (Mi)	Relief (Ft)	Order	Drainage Slope (Percent)
A	7.6	2.8	3400	3	1.6
B	8.6	2.9	3040	4	2.7
C	8.4	2.7	2920	3	3.8
Z	10.4	5.8	500	5	0.8

Table WQ-3
Major Fluvial Characteristics

Subshed	Total Miles of Stream	Drainage Density	Miles of Streams by Type Perennial	Intermittent	Percent FS (P&I)*
A	33.1	1.6	20.0	9.1	38
B	41.7	1.6	22.7	10.8	90
C	41.6	1.8	19.5	18.5	34
	97.4	1.6	33.7	38.6	30

*Percent of total perennial and intermittent stream miles that run through Fremont NF lands.

The numeric and narrative State of Oregon water quality standards that apply to the watershed are outlined below:

Antidegradation Policy: Requires that water quality in high quality waterbodies be maintained above standards unless no other reasonable alternative exists and the polluting activity is necessary and justifiable for economic or social benefit. However, even if these two criteria are satisfied and some water quality degradation is allowed, the antidegradation standard requires that water quality standards continue to be met and beneficial uses protected. High quality waters are those waters which meet or exceed those levels necessary to support the propagation of fish, shellfish, and wildlife and recreation in and out of the water, and other designated beneficial uses (Oregon Administrative Rules 340-41-006 [41]). The Antidegradation Policy also prohibits degradation of water quality in outstanding resource waters and waters failing to meet water quality standards. No waterbodies in the Bly RD have been nominated as outstanding resource waters. See Oregon Administrative Rules 340-41-965.

Bacteria: Effective on July 1, 1995, bacteria of the coliform group associated with fecal sources and bacteria of the enterococci group are not allowed to exceed the following values: a geometric mean of 33 enterococci per 100 milliliters based on no fewer than five samples, representative of seasonal conditions, collected over *a* period of at least 30 days. No single sample should exceed 61 enterococci per 100 ml.See Oregon Administrative Rules 340-41-965.

Biological Criteria: Requires that water quality be sufficient to support aquatic species without detrimental changes in the resident biological communities (Oregon Administrative Rules 340-41-027).

Dissolved Oxygen:

Salmonid fish (trout) producing waters: Dissolved oxygen concentrations not to be less than 90% of saturation at the seasonal low, or less than 95% of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes.

Non-salmonid fish producing waters: Dissolved oxygen concentrations not to be less than 6 mg/l.

Temperature:

Salmonid fish producing waters: No measurable increases in temperature are allowed when stream temperatures are 58°F or greater. When stream temperatures are 57.5°F or less, no more than a 0.5°F increase is allowed. When stream temperatures are 56° F or less, no more than a 2°F increase is allowed.

Non-salmonid fish producing waters: No measurable increases in temperature are allowed when stream temperatures are 72° F or greater. When stream temperatures are 71.5°F or less, no more than a 0.5 degree F increase isallowed. When stream temperatures are 70°F or less, no more than a 2°F F increase is allowed.

Turbidity: No more than a ten percent cumulative increase in natural stream turbidities is allowed.

pH: pH values are not allowed outside the range of 7.0 to 9.0.

Fremont National Forest Standards and Guidelines specific to Management Area 15 (Emphasis on Fish and Wildlife Habitat and Water Quality) and for Watershed Management (in general) are outlined in the Forest Plan.

Stratifications

Where data exist sufficient for analysis, stratifications by subshed were made to provide insight into subshed-wide conditions or to indicate cumulative watershed conditions.

Historic Condition (For both Key Questions 1 and 2)

Historic water quality conditions in the watershed are unknown. Some inferences about water quality can be made using available knowledge regarding historic fish presence and historic riparian vegetation. Dambacher, 1995, states that in 1919 along the Sprague River proper, a visiting botanist noted that there were "large stands of full grown quaking aspens along the Sprague River upstream of Beatty to above Bly; associated riparian species were willow, service berry, choke cherry, rose, golden current, bunch berry, and stinging nettle." Historic water quality conditions in the watershed can be extrapolated from this description and from examination of unaltered portions of the watershed.

Historic Dissolved Oxygen: Because of the presence of salmonid populations in the lower reaches and bull trout in the upper reaches, it is assumed that dissolved oxygen levels historically were within State water quality standards. The State standards for dissolved oxygen and temperature are based, in large part, on the biological needs of salmonids.

Historic pH, Conductivity, and Levels of Bacteria and Nutrients: There is no evidence that pH levels in the watershed were not within State standards historically. Conductivity was likely low, due to the probable low concentrations of dissolved solids in the water column. Because elevated levels of bacteria and nutrients are usually associated with livestock grazing and agricultural activity, it is not likely that these water quality parameters were elevated above State standards historically. Some bacteria and nutrients could have entered streams from wildlife use, but wild animals probably did not concentrate in numbers that would produce levels of bacteria and nutrients similar to those resulting from current livestock grazing.

Historic Sediment Regime: The presence of salmonids indicates there were adequate levels of clean spawning substrate. Also, substrate conditions were conducive to supporting a healthy food base in the lower reaches of the watershed. It would be expected that the lower reaches had the highest levels of suspended and deposited sediment. Therefore, except for immediately following disturbance events such as severe flooding and fire, sediment levels in the watershed system were relatively low. This *is* supported by the presence of stable soils and gentle slopes in the watershed, and the lack of a mass wasting mechanism active in other geomorphic terrains.

Historic Turbidity: Based on the sediment discussion above, turbidity levels were low except immediately following disturbance events.

Historic Temperature Regime: Historic channel and aquatic habitat conditions are discussed enders Issue 2 and Issue 4. Based on assumed channel conditions, it is probable that most sections of the watershed proper and its tributaries were shaded by trees, willows and other shrubs. This vegetation was likely dense, except in a few isolated areas where vegetation may have been affected by natural events such as insects, disease, fire, and beaver activity or flood damage. This vegetation likely limited solar input to streams. However, some solar input would have occurred from direct, overhead sunlight and, in sections of streams with westerly or south-westerly aspects, from afternoon sun. Ambient air temperatures also influenced stream temperatures. Salmonids were common throughout the lower reaches of the watershed and bull trout documented in the upper reaches. Bull trout do not thrive when when stream temperatures are above59 F. Therefore, it is likely that stream temperatures did not exceed 59^0 F for extended periods in stream reaches where bull trout were historically present. In the lower reaches of the watershed, it is not known *if,* for how long, or when Oregon State Water Quality Standards were exceeded **historically.** However, it is possible that during drought conditions, low stream flow in summer, or high ambient air temperatures the standard was exceeded in the lower reaches for limited periods.

Current Condition

Non-Point Source Pollution On a statewide rating system, the SF Sprague ranked #8 for priority surface waters receiving high impact ratings for health, recreation, or fisheries uses that are affected by water pollution. The watershed is one of the main tributaries to the Sprague River and it has influence over water quality in the Sprague River system.

In 1988 the Oregon Department of Environmental Quality "(DEQ) conducted an extensive inventory of water quality problems in the state, The 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution. In this report, waterbodies are identified that have serious or moderate nonpoint source pollution problems, or problems have been reported without challenge. Pollution types are classified according to source of information and pollution problems are rated severe or moderate. The results of the 1988 DEQ report for the watershed main stem are listed below. Tributaries to the watershed were not included in the report.

Lower Main Stem watershed to Day Use Area The following pollution types were identified as being severe problems through observation: turbidity, low dissolved oxygen, nutrients, pesticides, sedimentation, streambank erosion, decreased streamflow, insufficient stream structure, and excessive plant growths. The beneficial uses impacted are irrigation, cold water fisheries, warm water fisheries, other aquatic life, wildlife, water recreation, and aesthetics. The identified probable causes for the pollution are surface erosion, reduced surface permeability, changes in flow pattern and timing, elimination of thermal cover to the stream, traffic (roads), vegetation removal and the decline of the alluvial water table.

The management activities identified as causal mechanisms are irrigation withdrawals, altering of the physical structure in the channel, channeling and dredging and poor quality irrigation return water. These management activities are associated with land uses for irrigated and non-irrigated agriculture and livestock grazing.

Day Use Area to Confluence with Whitworth Creek: The following pollution types are causing moderate problems: turbidity, nutrients, sedimentation, streambank erosion, and insufficient stream structure. The beneficial uses impacted are cold water fisheries and wildlife. The probable causes are elimination of thermal cover to the stream, traffic (roads), vegetation removal, and the decline of the alluvial water table. Although no specific causes have been identified, probable sources include non-irrigated agriculture, livestock grazing, and timber harvest. No pollution problems were reported for the watershed above its confluence with Whitworth Creek.

In September, 1994 a macroinvertebrate sample was taken in the lower portion of the SF Sprague main stem above the Day Use area. The location of the sample site (lower portion of the watershed) allows for a general assessment to be made of the health of the aquatic system and the nonpoint pollution sources affecting water quality and aquatic habitat. The sample reported: There were indications of sedimentation in this stream reach; Cleanwater taxa were missing from the community which indicated that conditions were not suitable for these species; The Biotic Condition Index of 60 indicated that stress conditions were present in this stream reach.

In addition, the Modified Hilsenhoff Tolerance Index indicates that slight enrichment from organic matter is occurring, which could relate to elevated levels of nutrients. The species assemblage is dominated by sediment tolerant taxa. Taxa tolerant to organic enrichment are common. Moderately tolerant taxa (tolerant to higher water temperatures and sediment) are also common. Intolerant clean water taxa are absent. Based on macroinvertebrate community indicators, impacts are apparent from nonpoint source pollution, in particular increased temperature and sediment.

Turbidity: Turbidity refers to the amount of light that is scattered or absorbed by a fluid. Hence, turbidity is an optical property of the fluid, and increasing turbidity **is** visually described as an increase in cloudiness. Turbidity in streams ***is*** usually due to the presence of suspended particles of silt and clay, but other materials such as fine organic matter can cause turbidity as well. In general, a management activity that generates large amounts of suspended sediment will more or less proportionally increase turbidity. However, watersheds where the primary sediment source is clay or silt may have consistently high turbidity levels but only moderate concentrations of suspended sediment. Typically, there is a strong relationship between turbidity and discharge. This relationship will vary by site and by precipitation event. See Appendix WATER-1 for more information.

Turbidity measurements provide an indication of the amount of suspended material in the water, but the precise relationship between turbidity and the mass of suspended material depends on the size and type of suspended particles. This relationship must be established for each stream or sampling location and over the full range of discharge. The relative ease of measuring turbidity means that it is commonly used for monitoring nonpoint sources of sediment. The variability in turbidity among sites and over time generally makes it quite difficult to determine *a* natural or background level for any specified level of discharge. The combined uncertainty due to natural variability and measurement error makes it difficult to detect increases in turbidity due to forest harvest and other management activities.

Turbidity has been measured at several sites in the watershed (see Table WQ-4). However, more measurements are needed to determine the relationship between sediment, turbidity and discharge. In addition, without extensive monitoring it will not be possible to determine whether Forest Service management activities are causing the water quality standard for turbidity to be exceeded.

Table WQ-4
Results of Turbidity Monitoring by Subshed

Subshed	Stream	Location	Date(s)	Range of Measurements
A	Brownsworth	At Mouth	4/76	2.5 NTU*
B	S.F. Sprague	Below Corral Ck.	11/92-9/93	1.00-4.3 NTU
	S.F. Sprague	Below Camp Ck.	4/80-9/83	0.40-8.1 NTU
C	Whitworth Ck.	Above Dutch Oven Flat Ck.	11/92-9/93	3.60-15,0 NTU
	Whitworth Ck.	Unknown	3/79-9/82	0.40-13.0 NTU
Z	S.F. Sprague	Day Use Area	11/92-9/93	1.30-14.0 NTU
	S.F. Sprague	Blaisdell Crossing	4/76-9/82	0.05-15.0 NTU

*NTU – Nephelometric Turbidity Units

The turbidity measurements in Subshed Z are expected to be higher than other areas in the watershed because the cumulative effect of the watershed is being measured. However, the measurements taken at Whitworth Creek are higher than expected. These measurements indicate that there are conditions in this subshed that are causing either higher sediment levels in the stream to occur or there is a large optical difference in the source of the turbidity than what is present in other subsheds. Whitworth Creek is mostly privately owned. Further information is needed (monitoring or assessment of stream and watershed condition) before conclusions are made regarding this turbidity data.

Sediment: Only suspended sediment will be addressed in this analysis, due to a lack of data on bedload in the watershed. Suspended sediment is one component of the overall sediment budget. Changes in bedload generally have the greatest geomorphic impact, but these impacts may or may not be correlated with suspended sediment. Turbidity is highly correlated with suspended sediment, but this relationship must be determined for each basin and usually each site. See Appendix WATER-1 for a general description sediment types and their relationship to management activities.

Suspended sediment concentrations are determined by obtaining a water sample, drying or filtering the sample, and then weighing the residual sediment. Concentrations are typically expressed in milligrams per liter. Water quality standards are usually set in turbidity units rather than the concentration of suspended sediment. The primary problem with using suspended sediment as a monitoring tool is its inherent variability. Representative samples are difficult to obtain, and suspended sediment concentrations vary tremendously over time and space. It is often difficult to determine if there has been a significant increase in suspended sediment and whether an observed increase is due to management activities or natural causes.

These problems are exacerbated *as* one moves farther downstream because the impact of individual management activities is diluted and the amount of suspended sediment from other sources becomes larger.

The analysis of sedimentation impacts in the watershed were broken into two parts. The first part summarizes the products of the Erosion Potential Module from the SF Sprague River Watershed Assessment. The second part *assesses* the likely impacts resulting from the road network in the watershed and identifies problems areas where sedimentation effects are or are likely to occur.

1. Results of the Erosion Potential Module

The Erosion Potential Module produced a series of maps which can be used to assess current and potential sources of sediments in the watershed. Map WQ-3 shows the areas of high or moderate susceptibility to surface erosion.

Table WQ-5
Erosion Potential Ratings by Subshed

Subshed	Total Watershed Acres and Percent		Fremont NF Lands Percent	
	High	Moderate	High	Moderate
A	2,850 (23%)	1,370 (11%)	17%	8%
B	3,780 (24%)	710 (4%)	21%	4%
C	3,080 (21%)	4,360 (30%)	7%	16%
Z	20,770 (54%)	10,695 (27%)	18%	16%

Land use activity in the watershed was assessed and the resultant level of adverse impact to soils was categorized into three zones based on the degree of impact (high, moderate, and low). Then, this information was used in conjunction with the Erosion Potential Map to create a composite map, the Risk of Sheet Erosion Map (Map WQ-4). For example, if highly impacting land use activities occurred on soils highly susceptible to surface erosion, then the risk that sheet erosion has or will occur is high. Areas shown on Map WQ-4 as high or moderate are most likely to be sources of sediment to streams. Table WQ-6 shows the extent of each subshed rated *as* high or moderate.

Table WQ-6
Risk of Sheet Erosion Ratings by Subshed

Subshed	Total Watershed Acres and Percent		Fremont NF Lands Percent	
	High	Moderate	High	Moderate
A	1,450 (11%)	1,270 (10%)	6%	7%
B	1,230 (8%)	466 (3%)	6%	3%
C	1,892 (13%)	2,010 (14%)	3%	3%
Z	1,810 (5%)	8,720 (23%)	*1%*	16%

Based on this analysis, surface erosion *is* not likely to be a substantial source of sediment, particularly from Fremont NF lands. Subsheds C and Z have the highest potential for sediment production from surface erosion and Subshed B has the least.

The area within 200 feet of all streams mapped in GIS was overlaid on the Risk of Sheet Erosion Map to create a Delivery Potential Map (Map WQ-5). The likelihood of sediment entering streams is increased as the slope next to a stream increases and/or the distance between a stream channel and a disturbing activity decreases. Stream segments with a high or moderate delivery potential on Map WQ-5 highlight areas where eroded material has or is likely to enter the fluvial system. Table WQ-7 summarizes the length of streams with a high or moderate delivery potential by subshed.

Table WQ-7
Delivery Potential Ratings by Subshed

Subshed	Total Watershed. Acres and Percent		Fremont NF Lands Percent	
	High	Moderate	High	Moderate
A	5.7 (17%)	2.0 (6%)	9%	3%
B	3.2 (8%)	2.8 (7%)	3%	7%
C	4.5 (11%)	12.4 (30%)	2%	10%
Z	11.2 (12%)	29.8 (31%)	1%	17%

Subsheds C and Z are the most likely to have sediment enter stream channels from disturbances occurring next to stream channel and the likelihood is high enough to be of concern. However, the relative contribution of activities on Fremont NF lands near streams to the delivery potential *is* low to moderate in all subsheds.

Gully erosion can result in significant downstream delivery of sediment. However, the presence of gullies does not necessarily indicate high sediment yields. The presence of gullies does indicate that the landscape is dynamic and that the drainage network is undergoing transformation. The term "gully" is often used for any type of channel incision. To clarify the discussion of gullies for this analysis, the following definitions will be used.

Rill: An ephemeral channel and the smallest channel formed by runoff. A rill can be seasonal in nature and results from overland flow. A rill can be obliterated by plowing or frost action.

Gully: A relatively deep, recently formed eroding channel that forms on valley sides and on valley floors where no well-defined channel previously existed. There are two major types of gullies. One is a valley-side gully which *is* an extension of the valley network and which is incising into soil, colluvium and perhaps bedrock. The other type is the valley-floor gully which may be discontinuous or continuous and which is incising into alluvium and perhaps bedrock.

Incised Stream: A deep trench resulting from incision of an existing channel or a man-modified stream.

For this analysis, it is assumed that the Gully Erosion section of the Ecosystem Assessment Guide assesses rill and gully erosion only and the Bank Erosion section addresses stream channel incision. 41)

A Gully Erosion Potential Map (Map WQ-6) was created to map soil based on the potential for expected soil losses from rill and gully erosion when all vegetation is removed. Table WQ-8 summarizes the acres of severe, high, and moderate ratings for each subshed.

Table WQ-8
Gully Erosion Potential by Subshed

Subshed	Total Watershed Acres and Percent		
	Severe	**High**	**Moderate**
A	480 (4%)	7,866 (61%)	3,700 (29%)
B	0 (0%)	8,340 (52%)	6,400 (40%)
C	0 (0%)	5,280 (36%)	7,920 (55%)
Z	380 (1%)	28,290 (73%)	7,030 (18%)

Land use activity in the watershed was assessed and the adverse impact to soils was categorized into three zones: high, moderate, and low. Then, the information was used in conjunction with the Gully Potential Map to create a composite map called the Risk of Gully Erosion Map (Map WQ-7). For example, if highly impacting land use activities occurred on soils highly susceptible to rill and gully erosion, then the risk that rill or gully erosion has or will occur is high. Areas shown on Map WQ-7 as severe, high or moderate are most likely to be sources of sediment to streams. Table WQ-9 shows the extent of each subshed rated as severe, high, or moderate.

Table WQ-9
Risk of Gully Erosion Ratings by Subshed

Subshed	Total Watershed Acres and Percentage			Fremont NF Lands Percent		
	Severe	High	Moderate	S	H	M
A	410 (3%)	4,880 (38%)	4,380 (34%)	1	11	9
B	0 (0%)	2,810 (17%)	4,750 (29%)	0	16	22
C	0 (0%)	3,100 (21%)	6,170 (43%)	0	5	16
Z	**380** (1%)	6,120 (16%)	8,540 (22%)	<1	5	15

The information presented in Table WQ-9 indicates that gully erosion is most likely to occur in Subsheds A and C based on land use activity on private lands and the susceptibility of soils in these subsheds to rill and gully erosion.

It is less likely that gully erosion is occurring in Subsheds B and Z. Overall, rill and gully erosion probably *has* contributed some sediment to streams in the watershed. However, the relative proportion of sediment that could be directly attributable to rill and gully erosion is probably *less* than that attributable to roads.

Streambank erosion was also assessed in the Erosion Prediction Module. Bottom Line surveys were conducted on about 27% of the candidate streams on Fremont NF lands. Streams on non-Federal lands were not surveyed.

Results of these surveys were reported as percent of all surveyed stream miles that were classified as having unstable banks. The results of the survey are shown below.

Table WQ-10
Percent Unstable Banks by Stream

Subshed	Stream	Percent Unstable Banks
A	Brownsworth Creek	2-9
	Leonard Creek	2
	Hammond Creek	25
B	Camp Creek	10
C	Pothole Creek	29
Z	Paradise Creek	15
	Ish Tish Creek	5
	Badger Creek	10
	S.F. Sprague River	32

Stream bank instability is of concern along the watershed main stem and on Pothole Creek and Hammond Creek. Reaches of these streams with a high percentage of unstable banks are contributing sediment either directly into the watershed itself or are serving as a source of sediment to its tributaries.

2. Road Network Effects

Roads often account for a majority of sediment problems in a watershed and are often the links between sediment source areas (skid trails, landings and cutslopes) and stream channels. The majority of the transportation system in the watershed has been completed, with most roads located on gentle slopes (see Map WQ-8). The focus of this analysis is to identify roads producing a significant amount of sediment; primarily those roads that are in close proximity to and/or cross stream channels. The overall effect of the road system on sediment yield will be roughly analyzed by comparing the calculated amount of sediment delivered to streams from roads to estimated background rates and to the data that currently exists for sediment.

The estimated potential sediment delivery from roads in the watershed was calculated in the System Roads Module. The results of these calculations are given by subshed in Table WQ-11.

Also presented in Table WQ-11 are the results of estimations made for background sediment yields and crude calculations of measured sediment loads taken over the years. The methodology for estimating background sediment yields is outlined in the Ecosystem Assessment Guide.

Table WQ-11
Sediment Yield Estimates and Measurements by Subshed

Subshed•	Background Yields*	Potential Yield**	Total Yield	Measured Yield***
A	68	745	813	No Data
B	79	1,094	1,173	43
C	88	29	117	86
Z	169	No Data	N/A	618

Data for Subshed B measured in the upper watershed below Camp Creek. Data for Subshed C measured in Whitworth Creek above Dutch Oven Flat Ck. Data for Subshed Z measured in the lower watershed near Blaisdell Crossing.

"Natural" background sediment yields in tons per year. Calculated using the methodology outlined in the System Roads module.

** Estimated potential sediment delivery from roads in tons per year. Calculated using the methodology outlined in the System Roads module.

*** In tons per year. Amounts were provided by 1980 and 1981 monitoring reports. The highest sediment production data values were used, to represent the "worse case" scenario. These figures indicate the amount of sediment that has been delivered to the stream from all sources upstream of the monitoring site.

None of the figures in this table can be taken at absolute value. The usefulness of these calculations lies in the differences in orders of magnitude between calculated background ("natural") sediment levels, the potential sediment delivery from roads, and "actual" sediment yields. Three conclusions can be made from this data:

1) the relatively high measured sediment yield in Subshed Z is probably the result of roads and stream bank erosion. In addition, because the monitoring data was taken at a point several miles upstream from the outlet of the subshed, levels are probably even higher than what is shown here.

2) roads in Subsheds B and C are apparently not causing measured sediment yields to increase significantly above calculated "natural" levels. However, the measurement used to reflect conditions in Subshed B is likely low, because the monitoring point is located in the upper portion of this sub shed.

3) roads have the potential to affect sediment yields in Subshed A, based on calculated potential sediment delivery levels. Monitoring will be needed to test these conclusions.

Queries were made in GIS to determine the miles of road occurring within 200 feet of streams and the number of times roads cross streams. Table WQ-12 summarizes the results of these queries. Map WQ-9 displays the entire road network and its relationship to the drainage network in the watershed. Map WQ-10 shows only those road segments that are located within 200 feet of streams.

Table WQ-12
Roads Miles and Crossings

Subshed	Total # of Road Crossings	Crossings per Mile of Stream	% of Road Miles within 200 feet of Streams
A	56	1.7	21
B	76	1.8	11
C	94	2.3	16
Z	105	1.1	15

The levels calculated for Subsheds C and Z are lower than expected, because a significant portion of the watershed Main Stem is located in a canyon. This provides a topographic limiting factor to the construction of roads in proximity to these areas. In addition, the levels reported for Subshed Z are low because of the lack of GIS coverage for non-Federal land in this subshed. Overall, road crossings and road segments close to streams are having a moderate effect on the supply of sediment to streams in the watershed.

In summary, there are a variety of mechanisms for delivery of sediments to streams in the watershed watershed (sheet erosion, activity occurring next to streams, gully erosion, bank erosion, and roads). Overall, roads have the greatest influence on sediment levels, followed closely by bank and gully erosion. Sheet erosion constitutes a relatively small portion of the sediment budget. Sedimentation levels are elevated and are having an overall moderate impact on water quality in the SF Sprague watershed.

Temperature: Reductions in shading cover along streams can increase incident solar radiation and peak summer stream temperatures. Temperature increases are generally additive, so that an alternation of shaded and unshaded reaches usually is not effective in reducing or minimizing temperature increases. Removal of shading vegetation may also decrease the minimum nighttime temperature in winter by allowing more radiation heat loss. The largest changes in winter minima occur in small, shallow, slow-flowing streams that do not have significant groundwater inflow. In these streams, complete icing of the stream may be of concern.

Temperature data collected during the summer months are available for several streams throughout the watershed. Every stream monitored supports a salmonid fish population; therefore, the 58° F maximum temperature standard is applied.

All streams, throughout the entire monitoring record, exceeded the temperature standard at some time. Perhaps more important is the length of time that the standard was exceeded, which would indicate chronic problems. Table WQ-13 lists the number of days in the summer that the temperature in a stream exceeded

58 F. If several years of data were available, the "worst case" data (i.e. highest number of exceedance days) is listed.

Table WQ-13
Number of Days Where Temperature Standards Were Exceeded

Subshed	Stream	Site Location*	Number of Days Standard Exceeded
A	Brownsworth Creek	Mouth	140
		Middle	116
	Leonard Creek	Mouth	109
B	Upper watershed	Lower	102
		Upper	47
	Camp Creek	Mouth	89
		Upper	31
	Corral Creek	Mouth	38
	Buckboard Creek	Mouth	73
C	Whitworth Creek	Lower	92
	Pothole Creek	Lower	73
Z	Lower watershed	Upper	71
		Middle	99
		Lower	96

* Upper, Middle, Lower, and Mouth indicates in which portion of the subshed the monitoring point was located.

Based on data presented above and in other documents, the following generalizations can be made. The temperature standard is being exceeded in most years in most streams monitored in the watershed. Camp Creek and Corral Creek have the fewest days in which temperatures exceeded the standard. This is noteworthy, because Corral Creek and Camp Creek are located exclusively on Fremont NF land and these creeks have substantial segments that approximate their historic condition. This could mean that, for the SF Sprague watershed, it is not uncommon to exceed the State water quality standards during the late summer months. Temperatures also appear to increase during years with low summer flows.

Streams with several years of data generally had the highest number of days exceeding the standard during the lowest flow years (generally 1992, if monitoring occurred). However, streams with 90 or more days when the temperature standard is exceeded are exhibiting temperatures beyond likely historic ranges and adverse impacts to aquatic life are likely occurring.

Based on information contained in the Channel Condition module, stream temperature increases are caused by the following factors: changes in channel shape to one that is wider and shallower than what would occur if the stream was functioning properly; low flows due to drought and/or water diversions; and removal of or reductions in shading vegetation in many reaches throughout the watershed.

Because the general orientation of the watershed is to the south and west, reductions in shading allow for much larger increases in input of solar radiation than if the watershed was oriented to the north or east. Shading is addressed in Issue 2 and Issue 4.

Conductivity: Conductivity (or specific conductance) refers to the ability of a substance to conduct an electric current. The conductivity of water is a function of temperature and the concentration of dissolved ions. There is no water quality standard for conductivity applicable to the watershed. The range of conductivity for potable water is 30 to 1,500 umhos/cm; the conductivity of streams emanating from forested areas in the Pacific Northwest almost always **falls** at the low end of that range. Measured conductivity levels in the watershed range from 6 umhos to 187 umhos.

pH: pH is not sensitive to most forest management activities. If there are high amounts of algal growth in a water body, pH may vary considerably over a 24-hour period. Maximum pH values usually occur in the afternoon when photosynthetic activity consumes carbon dioxide and dissolved oxygen concentrations are at a maximum. Minimum pH values are observed at night when carbon dioxide is being released by algal respiration. The water quality standard for pH requires values to lie between 7.0 and 9.0. pH measurements in the watershed are few. All available measurements were examined and all pH values in the watershed range from 7.8 to 8.0. pH is not likely to be of concern in this watershed, in view of the management activities that occur and based on a lack of problems in the past.

Dissolved oxygen: Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water. DO is critical to the biological community in a stream and to the breakdown of organic material. For slow moving streams with high populations of algae, large diurnal fluctuations in DO can occur as a result of algal photosynthesis and respiration. During the day, photosynthesis may be a source of oxygen. At night, photosynthesis ceases and oxygen is used for respiration. DO levels are often lowest just before dawn. The water quality standard for DO that is most important to consider is that for salmonid-producing streams. This standard requires that DO levels be at or above the 90% saturation level at the seasonal low. DO measurements in the watershed are few, and all were taken in salmonid-producing streams. All measurements available were examined. In August of 1993, there were three sites that did not meet minimum DO standards: Paradise Creek above Badger Creek (83.6% of saturation), the watershed at the Uwatershed Day Use Area (85.2% of saturation) and the watershed above Paradise Creek (85.2% of saturation). A measurement of DO in August of 1977 in the watershed at Blaisdell also did not meet standards (81% of saturation). It is likely that other streams in the watershed also do not meet DO standards, particularly during low flow years.

Bacteria: Bacterial contamination is of concern in all waters that humans come into contact with, but has little effect on aquatic organisms. Bacterial contamination can result from dispersed and developed recreation, wild and domestic animal populations, and human settlements. No known measurements of bacteria levels in streams of the watershed exist. With livestock grazing occurring along almost all of the stream miles in the watershed, this water quality parameter should be measured.

Nutrients (Nitrogen and Phosphorus): Nitrogen is one of the most important nutrients in aquatic systems. Most of the effects of nitrogen result from stimulation of the growth of bacteria and algae (primary productivity) when increased levels of nitrogen are available. However, studies have shown that the growth of algae may not occur if light or other nutrients such as phosphorus are lacking.

For many forest streams, a small or moderate increase in primary productivity could provide positive benefits to the aquatic community. However, if plant respiration begins to deplete dissolved oxygen levels, the net effect is negative. Logging, fire, fertilization, and livestock grazing can substantially increase nitrogen levels in streams. Phosphorus is an essential nutrient for plant growth. In aquatic ecosystems, phosphorus is usually the limiting nutrient to algae growth. Forestry practices generally do not affect phosphorus levels, but human and livestock waste can contribute phosphorus to streams.

Although no national standards have been established, a nitrate concentration of less than 0.3 mg/L and a phosphorus concentration of less than 0.10 mg/L is recommended to help prevent eutrophication. In 1993 a nutrient assessment study was conducted in the upper Klamath Basin. Several monitoring points are located in the watershed. All data for the watershed was examined, and several sites exceeded recommended levels of nitrate and phosphorus. The sites that met or exceeded recommended nitrate levels were: Paradise Creek above Badger Creek (0.3 mg/L) and Blonde Springs above Buckboard Creek (0.3 mg/L). A measurement of 0.2 mg/L was recorded at Round Spring on Buckboard Creek. One site exceeded the recommended level of phosphorus: the watershed below Corral Creek (0.110 mg/L). Measurements of 0.090 mg/L and 0.80 mg/L were obtained from an unnamed creek draining Lantern Flat and Paradise Creek above the watershed, respectively. Based on land use activities occurring in these areas, it is likely that livestock concentrations are contributing towards elevated nutrient levels in certain sections of the watershed and its tributaries.

Summary

Sections of the SF Sprague and its tributaries are currently not meeting State of Oregon or Forest Plan water quality standards for temperature and dissolved oxygen. Sediment is also a problem, mainly from roads and gully and streambank erosion. There are a few localized areas with elevated nutrient levels, but the levels are such that adverse impacts are probably not occurring. Because changes in water quality have been occurring on both National Forest and non-Forest land over time and extensive water quality data is lacking, it cannot be said when or exactly where the Antidegradation Policy and the Biological Criteria standard were or are being violated.

Desired Condition

State Water Quality Standards are being met or *exceeded:*

Water quality is sufficient to support aquatic species without detrimental changes in the resident biological communities.

In salmonid fish (trout) producing waters:

dissolved oxygen concentrations are not less than 90% of saturation at the seasonal low, or less than 95% of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes and

stream temperatures are 58°F or less with no temperature increases occurring due to activities on Fremont NF lands.

In non-salmonid fish producing waters:

dissolved oxygen concentrations are not less than 6 mg/1 and

stream temperatures are 72°F or less with no temperature increases occurring due to activities on Fremont NF lands.

No more than a ten percent cumulative increase in natural stream turbidities is occurring due to activities on Fremont NF lands.

pH values are within the range of 7.0 to 9.0.

Bacteria of the coliform group associated with fecal sources and bacteria of the enterococci group do not exceed the following values: a geometric mean of 33 enterococci per 100 milliliters based on no fewer than five samples, representative of seasonal conditions, collected over a period of at least 30 days. No single sample exceeds 61 enterococci per 100 ml.

Identified beneficial uses are being protected by maintaining water quality consistent with downstream needs and resource protection.

The sediment regime approximates conditions under which the aquatic system evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage and transport.

Site-specific BMP are applied to all management activities to ensure protection of water quality and favorable conditions of flow.

Cumulative watershed impact limits are being met.

Land Use Effects, Condition Trends and Evaluation

Stream temperature increases above State standards have been caused by the following factors: changes in channel shape to one that is wider and shallower from livestock trampling of stream banks, road building near streams, straightening and dredging of stream channels, and logging activity near and across streams; low flows due to drought and water diversions; and removal of and or reductions in shading vegetation from logging, livestock grazing and wildfire.

Sediment is being delivered to streams from roads (via cutbanks, ditches and fill for stream crossings) and streambank and gully erosion. Sheet erosion *is* contributing relatively little sediment to streams. Sediment is the most likely cause of elevated turbidity levels in certain streams.

Dissolved oxygen levels do not meet State standards due to high water temperatures and low flows. Loss of large woody debris (reducing turbulence and mixing of oxygen into the water) and elevated algae populations (from elevated nutrient levels) are also likely contributors to low dissolved oxygen levels.

Nutrients are slightly elevated above recommended levels due to livestock concentrating around water sources during late summer months when water levels are lowest. Bacteria levels are also likely to be elevated in these areas, but no data is available regarding bacteria levels in the watershed. No adverse impacts to conductivity and pH are occurring or are likely to occur.

Overall water quality conditions (except for sediment, turbidity and temperature) are likely to continue near current levels into the future. Although conditions on Fremont National Forest Lands will improve, conditions on private land will not. Because of the large private landholdings within the watershed, improvements in water quality on National Forest lands will have limited impact on the watershed as a whole. Sediment and turbidity levels will decrease on Fremont NF Lands *as* road closures and obliterations *decrease* road density and the number of stream crossings. Surfacing of roads will also decrease sediment runoff. Sediment and turbidity will decrease further as revegetation of eroding cutbanks and other projects imporve riparian area conditions.

Temperature will likely remain at current levels until increases in canopy closure occur or stream channel conditions improve. Temperature and dissolved oxygen standards will likely continue to be exceeded in both the short term and long term, except in areas of concentrated National Forest ownership where intensive restoration efforts are undertaken. If a large wildfire or flood event occurs in the watershed, then water quality could significantly decline (mainly sediment, turbidity and temperature) until recovery occurs.

If a large wildfire or flood event occurs in the watershed, then water quality could significantly decline (mainly sediment, turbidity and temperature) until recovery occurs.

Issue #2: Functions in the riparian ecosystem within the South Fork Sprague River watershed have been altered from their assumed historic condition.

Key questions

1. How do land management activities affect riparian ecosystems and are these activities preventing recovery where these ecosystems are currently not functioning properly?

   Parameters: bank stability, channel morphology, soil condition, soil drainage/lowering of the water table, and vegetation community.

2. How have changes in riparian ecosystems affected other resources such as fish and wildlife habitat and downstream irrigation needs?

   Parameters: pools, temperature, base flows, and water quantity (temperature and turbidity).

Stratifications

Four inherent criteria were used to stratify the watershed: geology, soil type, topography, and potential natural vegetation. One ephemeral criteria, land use, was also used.

A broad overview of geologic rock types, soil types, and related topography provided the initial stratification. Landscapes occurring on gentle topography were separated from landscapes occurring on steeper topography. Potential natural vegetation is closely tied to soil type and especially to soil depth. These five factors were used to stratify the upland portion of the watershed into impact zones based on land sensitivity and degree and effect of management related activities.

Riparian ecosystems were stratified by three inherent criteria: channel form and/or morphology, channel reach, and potential natural vegetation. Ephemeral criteria utilized were land use, actual vegetation, and channel modification. Channel morphology is essential in determining condition and sensitivity to land use. Meadow systems are primarily C/E channels which are much more sensitive than B channel systems. Each stream reach was field surveyed and site specific criteria gathered along entire channels.

Historic Condition

Historical conditions of riparian ecosystems within the SF Sprague watershed were generally much different than conditions today. The exceptions are the higher elevation riparian areas within and adjacent to the Gearhart Mountain Wilderness and areas adjacent to Coleman Rim. As a general rule, riparian ecosystems at higher elevations have not been changed as much as those at lower elevations.

Coniferous forests associated with riparian ecosystems, generally B channels, provided high quantities of large woody debris (LWD), very stable banks, and high amounts of channel shading. At the lower elevations deciduous species replaced conifers. It is likely that black cottonwood and aspen were more common and provided similar LWD, shading, and bank stability to the channel system.

Forested lands adjacent to riparian ecosystems consisted of old-growth ponderosa pine stands at lower elevations and old-growth mixed conifer stands at higher elevations. These stands were present along both sides of the channel and/or riparian area. Large woody debris densities per mile of channel were very high as all material eventually became available as individual trees died.

Meadow ecosystems associated with riparian areas consisted of dense, lush growth of sedges, rushes, willow, aspen and other riparian species. Banks were very stable with a very high amount of undercutting. Consequently, width to depth ratios were much lower in these areas, mostly C and E channels. Stream shading was very high from willow, aspen, black cottonwood, mountain alder and other overhanging bank vegetation. Water tables were generally higher within these ecosystems. This resulted in much lower peak summer water temperatures and higher peak winter temperatures historically. It is likely that peak water temperatures in tributaries to the SF Sprague River were 60°C or lower.

Upland soil conditions were pristine. Soils had low bulk densities and high infiltration rates throughout the watershed. Water infiltrated the soil or flowed naturally over the surface without being intercepted by roads and collected. Compaction did not exist, and water infiltrated the soil to a higher degree which contributed to maintaining summer base flows and perennial flows. Historically, more streams and reaches of streams higher in the watershed were perennial.

Upland soil loss rates generally were less than 0.5 ton per acre per year. Sediment delivery to the channel was very low due to the undisturbed nature of the watershed. However, high intensity wildfires would have occasionally resulted in substantial increases in soil erosion rates and sediment delivered to the stream channel.

Soil conditions within riparian ecosystems were also pristine. Compaction, puddling, and displacement did not exist. Soil bulk densities were relatively low contributing to high infiltration rates, lush vegetative growth, and very stable stream banks. Water tables within the soil profile were generally higher because adjacent channels had not widened or downcut (primarily C/E channels).

Historically, the lower portion of the SF Sprague River and upstream open meadow reaches were E stream types. They were meandering and highly sinuous channels characterized by narrow width to depth ratios (<12), very stable banks (greater than 90%), and dense stands of riparian shrubs, sedges, and rushes throughout. The water table was close to the soil surface throughout the year which contributed to the dense, lush vegetation and high summer base flow. Stream shading was very high from dense willow growth, overhanging sedge/rush vegetation and undercut banks.

Most non-meadow portions of the SF Sprague River were B channel reaches. They were moderately entrenched, very stable systems with high quantities of LWD, stable banks and highly shaded *as a* result of the large amount of old-growth conifers.

Peak summer temperatures were lower and pools were deeper as a result of bank stability, LWD, and very low quantities of sediment delivered from the uplands. Width to depth ratios likely were somewhat lower especially at the lower elevations.

Historical conditions of the other riparian ecosystems were analagous to the SF Sprague River. Brownsworth, Leonard, Hammond, Long, Alder, Buckboard, Pothole, Whitworth, Ish Tish, and Paradise Creeks all had high densities of LWD and stream shading. In general, width to depth ratios along B reach channels were somewhat lower along certain creeks. However, because B channels are inherently stable, streams such as Brownsworth Creek, Leonard Creek, and Whitworth Creek were similar as compared to their current channel morphology. Of all the streams within the watershed, it is likely that the upper reaches of Camp Creek, Corral Creek, and the SF Sprague River proper historically were the most similar as compared to today's conditions.

Historically, riparian ecosystems were in excellent condition. That condition was due to parameters such as high levels of LWD, the lush riparian vegetation, high water table, stable and undercut banks, and degree of stream shading. Stream temperatures were lower, pools were deeper, summer base flows were higher and water quality was higher throughout the watershed. It was due to these historic conditions that salmon, steelhead, shortnose suckers, and Klamath large scale suckers spawned in the SF Sprague as well *as* its major tributaries (Fortune et. al. 1966). Also, the lush riparian vegetation was pristine and provided ideal habitat for riparian dependent wildlife species.

Current Condition

The current conditions of riparian ecosystems within the SF Sprague watershed indicate that portions of the riparian ecosystems: 1) are deficient in LWD and stream shading, 2) have unstable banks and excessive width to depth ratios, 3) have lowered water tables and reduced base flows, and 4) have riparian plant communities that are not at potential. Current conditions also indicate that upland disturbances have reduced soil productivity and increased erosion and sediment delivery to the stream channel.

Generally, riparian ecosystems higher in the watershed, such as along Corral Creek, Camp Creek, and the Upper SF Sprague River, are in the best condition. Conditions are more degraded, as a general rule, along the lower reaches of various stream channels throughout the watershed.

The Level II Riparian Survey conducted by the Bly Ranger District showed that, with minor exceptions, the SF Sprague River proper and the upper reaches of Camp and Corral Creek are at potential. The term "Potential" was defined as meaning 85% of the plant association within that reach having the presence of key species. Reaches are changed and plant associations are not at potential due to the introduction of non-native species or by the elimination of key species and are classified *as* degraded or "Disturbed Plant Community" types.

LWD is generally insufficient within most riparian ecosystems within the watershed. On the SF Sprague River, densities along the seven reaches inventoried range from none to 61 pieces of large woody debris per mile (minimum piece is 12 inches small end diameter and 35 feet long).

Six of the seven reaches were below recommended levels of 60 pieces per mile (pine/pine associated stands). Large woody debris densities are generally sufficient only along Leonard Creek riparian ecosystems, but are below recommended levels along all other stream systems.

One of the effects of the changes in plant associations and management activities is the degree of bank stability and undercutting that currently exists within the watershed. Stability within the SF Sprague watershed ranges from 508 to 98%. Brownsworth, Camp, and Leonard Creeks generally have high stability whereas bank conditions on the remaining streams range from poor to good depending on elevation, stream channel morphology, and vegetative condition.

Width to depth ratios are excessive on some reaches of the SF Sprague River and portions of other lower elevation riparian ecosystems. Ratios are generally acceptable on Brownsworth and Leonard Creeks and upper elevation portions of all other streams. The amount of stream shading provided by riparian and adjacent coniferous ecosystems is also generally low. Riparian ecosystems dominated by mountain alder and/or located at upper elevations generally provide sufficient shade to the stream channel surface. This includes Leonard, Hammond, Long, Camp, and Alder Creeks and portions of other upland reaches.

Lowering of the water table, and subsequent loss of base flow, within the SF Sprague River has only occurred in a few areas. This is the result of relative stability of the watershed due to geology, soil type, and channel morphology. Channel downcutting has occurred on portions of the lower river as well as some upland, low gradient meadows.

Cumulative adverse soil impacts are high and exceed 20% for much of the upland forested ecosystems. Only the Gearhart Mountain Wilderness, canyon lands adjacent to the SF Sprague River, the upper Pothole/Whitworth Creeks subbasins, and the open non-forested lands are adversely effected less than 20%.

The extensive road system has reduced soil productivity, increased overland flow, increased erosion, reduced base flow and increased sediment delivery to the SF Sprague River.

Desired Condition

Riparian ecosystem function and health *is* maintained and improved where necessary by enhanced management of livestock, timber harvest, roads, fire and recreational activities. This leads to improved vegetation and soil conditions which in turn leads to proper function and health of the aquatic ecosystem. Streams have excellent water quality and quantity with stable and productive riparian ecosystems. Summer water temperatures are reduced, stream flows are increased and stream channel morphology adjusts to a natural condition as stream banks are vegetated and stabilized. Width to depth ratios are reduced and banks will build and undercut *as* sediment is deposited. Stream banks are well vegetated and are greater than 80% stable (Forest Plan and PACFISH). Non-forested portions of the watershed have an abundance of shrubs in the riparian zone and along stream banks and/or luxuriant growth of deep rooted sedges, rushes, grasses and forbs. Root systems of these plants allow development and maintenance of stable undercut banks. Bank are undercut 75% or more of potential primarily on C/E stream channels (PACFISH).

Riparian ecosystems have a "brushy look" with willows, alders and other deciduous species (Forest Plan). Shade cover ranges from 50% to 75% of the stream surface or 100% of site potential if less than 50%. Vegetation provides summer and winter thermal regulation which will lower summer temperatures and raise winter stream temperatures. State temperature standards (maximum of 58°F) are met. W/D ratios (bankfull stream channel width to bankfull mean depth) are less than 12 for A and E stream channels and more than 12 but less than 20 for B and C stream channels (Rosgen).

Riparian ecosystems are growing large conifers to their potential. These trees are available for LWD for streams and bank stabilization. Adjacent forested ecosystems provide more than 60 pieces of LWD per mile (pine/pine associated stands) greater than 12" small end diameter and greater than 35' in length (PACFISH). Riparian function and health is good. Recruitment of LWD into stream channels and upper banks provides structural habitat for both aquatic and riparian dependent species *as* well as unique genetic fish stocks and native plants.

Long-term efforts to restore bank stability are linked with reducing the causes of the instability. Causes may be due to several factors, including hoof shear from livestock, loss of large wood recruitment, lowering of the water table, changes in plant community and loss of root strength, increased peak flows from upland timber harvest and road building and stream channel straightening. Evidence of eroded banks is minimal. Riparian sediment sources are close to the range at which aquatic and riparian dependent species are adapted.

Soil loss related to system roads, skidtrails, landings and other management activities is less than 3 tons/acre/year. Regional soil standards are achieved during all management activities. Cumulative adverse soil impacts do not exceed 20%. Overall density for the roaded portion of the watershed will not exceed 2.5 miles per square mile (Forest Plan). Soil productivity is maintained or enhanced while the hydrologic regime is improved and adverse soil effects are reduced resulting in an improved aquatic and riparian condition.

Poor soil condition (compaction/puddling) in riparian ecosystems are less than 25% on all riparian ecosystems (Forest Plan). Soil and native plant productivity will be enhanced and the hydrologic regime will be improved by increased infiltration and percolation of water. Seasonal low flows are increased as water tables are restored.

Land Use Effects, Condition Trends and Evaluation

Current conditions of riparian ecosystems within the SF Sprague River are the result of extensive land management activities which have occurred throughout the watershed. Timber harvest of both upland and riparian areas has resulted in adverse effects to riparian ecosystems. System roads, temporary roads, skid trails and landings have removed vegetation, compacted soils, increased overland flow and increased erosion.

These disturbances have effected the hydrologic regime of the watershed, including the riparian ecosystem, especially where roads and skid trails are located within drainages and/or riparian areas.

Grazing has also had a significant adverse impact on riparian ecosystems on some areas. Cattle tend to concentrate near water and where forage stays lush and palatable later into the grazing season. Soils within riparian ecosystems usually are very susceptible to compaction/puddling and hoof shear due to the high moisture content. Poor soil condition and bank sloughing have resulted from this activity. Some of this current condition is the result of grazing many years ago when cattle numbers were much higher and grazing occurred earlier and later in the year.

Two large high intensity fires occurred within the watershed, the Round Butte fire occurred in 1958 and the recent Robinson Springs fire in 1992. Salvage logging of wildfires has resulted in high soil disturbances by removing upland organic matter and large woody debris and shading adjacent to stream channels.

Salvage logging in the Round Butte Fire reduced the long term source of LWD and shade for the SF Sprague River, Brownsworth and Hammmond Creeks.

Estimated soil loss rates relating to roads and all other soil disturbing activities is estimated to be over 3 tons/acre/year. This is due to the current road density.

In addition, skid trails, landings and temporary roads associated with timber harvest, as well as to other soil disturbing activities, have contributed to exposed mineral soil. These effects have reduced upland soil productivity, increased overland flow, increased erosion, reduced base flow and increased sediment delivery to the SF Sprague River.

Management activities have resulted in changes to the riparian ecosystem and are the reasons for the current condition. They have changed the quality and type of riparian vegetation, soil condition, and productivity and the quantity and type of upland vegetation. This has led to reduced stream shading, reduced LWD, increased width to depth ratios of stream channels, reduced bank stability and undercutting, lowered the water table, compacted upland and riparian soils, and increased upland soil erosion. In addition, the potential for recruitment of LWD in the future is low within some riparian ecosystems because of past timber harvest, wild fires and/or current road locations.

Excessive width to depth ratios usually correlate to the degree of bank stability. If banks are non-vegetated or not protected by LWD or boulders then erosion increases and the stream channel widens and becomes shallower.

Grazing activities within riparian ecosystems have compacted/puddled surface soils which has reduced infiltration and plant growth and diversity. Stream banks have been exposed by hoof shear, soil productivity reduced, water tables lowered and base flows reduced. Riparian ecosystems associated with Pothole Creek have been adversely effected to the greatest extent.

The hydrologic regime has been changed by timber harvest, the road network and grazing so that less precipitation is stored in the soil mantel. Moisture enters the stream channel at a more rapid rate and base flows from riparian ecosystems have been reduced so that currently more streams are intermittent during the low flow summer months.

These factors have had a direct effect on salmonids, riparian dependent species, and water quality and quantity. Stream temperature monitoring data shows that peak summer temperatures exceed the state standard of 58F most years for most of the major stream channels and subbasins. Temperature data shows that streams at the higher elevations and those adjacent to the Gearhart Mountain Wilderness also exceed the standard but to a much lower level. Stream temperatures increase as a result of reduced stream shading, unstable banks, increased width to depth ratios and lowered summer base flows. Reduced summer base flows adversely effect fish and downstream irrigation needs. Increased sediment from the uplands and from unstable banks result in higher water turbidity and greater embededness of spawning gravels. Reduced LWD and exposed streambanks lowers the amount of cover for fish and increases susceptibility to predation and high runnoff events.

ISSUE #3: Flow rates have been altered in terms of base flow, peak flow and timing of peak flow.

Key question

1. Has the natural drainage regime in the watershed been altered by grazing, forest management, road building, and diversion activities?

   Parameters: timing and frequency of peak flows and base flow, cumulative effects, soil moisture storage, soil drainage, and current disturbances.

Introduction

The water that falls within a watershed that is not used by existing vegetation will either flow over land or through the soil to the lowest points in the watershed. This water should appear in springs, streams or rivers that drain the watershed. Appendix WATER-1 describes the effects that management activities have on stream flow and watershed function.

Soil disturbance associated with roads, landings, skid trails, and mechanical site preparation can cause hydrologic changes affecting the timing, volume, and quality of runoff. Infiltration and percolation through the soil can be reduced by compaction, removal of vegetation, or as a result of hydrophobic soil conditions associated with intense burning. An increase in the volume of runoff delivered directly to stream systems may increase the magnitude and change the timing of peak flows. Soil compaction and an extensive road network can also cause some precipitation to enter streams as surface runoff rather than through the groundwater system, thus slightly decreasing the amount of water available to enter the aquifer. Groundwater aquifers tend to moderate the runoff cycle and stabilize stream flows, thus minimizing the potential for streambank damage. Reduced infiltration and percolation rates associated with soil disturbance, particularly in or adjacent to riparian areas, can reduce the rate and quantity of groundwater recharge and the amount and duration of summer base flows. Roads can provide an effective drainage network for a watershed, which can cause water to leave as surface runoff through ditches.

Stratifications

Stratifications by subshed were made based on whether it provided the most insight into subshed-wide conditions or reflected measurements taken at or near the outflow of the subshed (to indicate cumulative watershed conditions).

Historic Conditions

The watershed has three primary functions: capturing water, storing it in the soil, and releasing it safely. Capture is the process of getting water from the atmosphere into the soil. All moisture received from the atmosphere, whether as rain or snow, has the maximum opportunity to enter the soil at the point where it fell. Plant cover on the soil surface traps rain, which helps precipitation seep into the soil rather than running off the site.

Plant cover reduces raindrop impact upon the soil surface and minimized soil crusting (the creation of an impervious soil surface) and erosion. Plant litter and organic matter absorbs rain and melting snow and helps keep soil moist. Plant cover traps snow at or near the soil surface and reduced soil freezing by acting as insulation.

Keeping the soil from freezing and storing snow "in place" helps melting snow enter the soil. Healthy vegetative cover with its accompanying root *mass* keeps soil permeable so that moisture readily percolates into the soil for storage.

Storage of water in soil varies depending on its depth, texture, and structure. Once water enters the soil, it is stored between soil particles. Moisture retained within the soil is used by vegetation during the growing season, when rainfall was scant. Moisture leaves the soil in three ways: through plants that grew on the site; after the soil becomes saturated, the excess water flowes through the soil and becomes groundwater; and through direct evaporation from bare soil surfaces. Plants and litter on and in the soil help reduce soil evaporation through shading the soil and providing protective cover.

Safe Release is the processby which water moves through the soil to *seeps,* springs, and ultimately into streams and rivers. The amount and rate of water released depends on how much water is already in the soils of the uplands, riparian areas, and streambanks. If soils are filled with moisture to their capacity, then the excess from rain or melting snow is released downstream. Generally, most precipitation is delivered at a rate that is within the capability of soils to absorb it. Thus, overland flow occurres infrequently and only during high intensity summer thunderstorms or rapid snowmelt.

No direct information on historic watershed conditions or water quantity *is* available for the watershed. It is assumed that watersheds functioned properly (as outlined above), except after severe fire events. Fire can create adverse soil cover and hydrophobic soil conditions that affect infiltration rates and increase peak runoff amounts in portions of a subshed. Adverse effects from fire should recover naturally.

Current Conditions

Base Flow: In the SF Sprague watershed, like most of the western U.S., minimum streamflow occurs during late summer and early autumn. This decline in discharge is due to a combination of low precipitation, reduced drainage from the soil and bedrock, and sustained high evapotranspiration. Base flow, or summer low flow, is important for maintaining aquatic and riparian habitat and as a late-season water source for livestock and wildlife.

In lower elevation white fir-mixed conifer stands, succession in the absence of fire has caused a shift from ponderosa pine-dominated stands to white fir-dominated stands. This has resulted in higher stocking levels and increased canopy closure in some stands. The change has also likely increased transpiration rates. The increased stocking and species shift in these stands may have slightly lowered base flow levels to some extent, due to increased use of late season soil moisture.

Map WQ-2 shows the distribution of perennial, intermittent, and ephemeral streams in the watershed. No attempt was made to determine the upstream limit of ephemerality nor the watershed area at the upstream limit of ephemerality due to a lack of time and data. No abnormal distribution of perennial, intermittent, or ephemeral streams in the watershed has been noted.

Base flows were estimated by sketching hydrographs of Brownsworth Creek, Whitworth Creek, and the SF Sprague River (at Blaisdell at the SF Sprague River Day Use Area). These hydrographs consist of miscellaneous instantaneous flow measurements generally taken 1979 to 1982 and/or from 1992 to 1994. Because none of these streams have a complete, uninterrupted flow record, base flows were inferred from inflection points in the hydrograph. The years 1979 to 1994 saw several important hydrologic events: 1979, 1981 and 1990-1992 were years with below normal precipitation and 1980, 1982 and 1993 were years with above normal precipitation. Based on these hydrographs, base flows were estimated for each subshed and the base flow per unit of watershed Area was calculated *(see* Table HYD-1).

Table HYD-1 Base Flows

Subshed	Stream	Base Flow	Base Flow/sq.
A	Brownsworth Creek	2- 9 cfs	0.1-0.5 cfs/sq. mi.
B	S.F. Sprague Blaisdell	5-20 cfs	0.1-0.4 cfs/sq. mi.
C	Whitworth Creek	.5- 3 cfs	.02-0.1 cfs/sq. mi.
	S.F. Sprague mi. Day Use Area	8-22 cfs	.06-0.2 cfs/sq.

These calculations suggest that Subsheds A and B, which emerge from the Gearhart Mountain Wilderness and the northern portion of the watershed, contribute a higher proportion of the base flow in terms of yield per square mile to the SF Sprague main stem. In terms of actual flow, Whitworth Creek provides a major portion of the base flow to the upper watershed main stem.

The USGS publishes statistical summaries of stream flow data from stream gaging sites throughout Oregon. In their 1993 report, annual low (base) flow and high (peak) flow frequency analyses and flood frequency summaries are provided for gaging stations that had at least 10 years of record. For this analysis, the nearest gaging station (located on the Sprague River near Beatty) was used for comparison with observed flows in the watershed.

In 1981, the Sprague River near Beatty experienced its lowest base flows on record. Only one of the four sites listed in Table HYD-1 was monitored in 1981--watershed Blaisdell. However, this site has had several measured base flows that closely approximate flows measured in 1981. In 1992 there were low flows recorded in the Sprague River near Beatty that constitute a 6-7 year low flow event. This means that a flow that is lower than 1992 flows would occur on an average of every 6 to 7 *years.*

Flows were measured in Brownsworth Creek and in the watershed at the Day Use Area site in 1992. Low flows measured in 1994 are very close to those measured in 1992, the high precipitation received in 1993 did not make a noticeable difference in observed 1994 base flows. In addition, other *years* of higher precipitation have not had an apparent affect on base flows.

The Forest Plan contains recommendations for minimum recommended average monthly stream flow for the watershed at Alder Creek (which is about 2.5 miles upstream from Blaisdell) and at the Day Use Area site. Flows from the Blaisdell site will be used as a surrogate for flows at Alder Creek because they are comparable to what would likely be measured at Alder Creek. Recommended base flows range from 5-10 cfs at Alder Creek to 15-45 cfs at the Day Use Area site.

Base flows at watershed Blaisdell in 1979 (the year with the lowest recorded base flows) were at the recommended minimum (5 cfs) in August. Flow data more recent than 1984 is lacking for this site, except for one flow measurement taken in 1990. In September of 1990 flow at Blaisdell was less than 4 cfs, which is below the recommended minimum flow level. All other measured flows were above recommended minimum levels. Flows in the watershed at the Day Use Area in 1992, 1993, and 1994 were below recommended minimum flow levels in August through January for all years and, in 1992, for most of the year.

It is unknown how the recommended base flows contained in the Forest Plan were derived; if they were based only on historic data, it is possible that base flows in the watershed are now lower than historic levels. There is not enough data available to determine if base flows have, in fact, been reduced. Drought probably has the greatest effect on base flows, but poor channel and riparian condition along some segments of the watershed main stem and its tributaries increase the contribute to the negative effect of these low flows. Vegetation removal has likely had a small effect on increasing water available for base flow, but this may be offset by increased stand densities due to fire suppression. Existing base flows are having an adverse effect on aquatic life and are exacerbating temperature and other water quality problems.

Peak Flow: Peak flows refer to the instantaneous maximum discharge associated with individual storm or snowmelt events. In the watershed, peak flows are primarily generated by spring snowmelt. However, summer thundershowers and rain-on-snow events may be responsible for the largest runoff events in some small subwatersheds. Management activities can increase the size of peak flows through a variety of mechanisms, including: road building, compaction, removal of the forest canopy, higher soil moisture levels due to the reduction of evapotranspiration, increased rate of snow melt, and a change in the timing of flows that results in a synchronization of previously unsynchronized flows. Any change in the size of peak flows is most likely to decline in magnitude as one moves downstream. Proportionally larger increases in the size of peak flows will occur downstream only if the timing of peak runoff in the managed basin is altered in such a way that it becomes synchronized with peak runoff in other tributaries.

Peak flows were estimated from sketching hydrographs of Brownsworth Creek, Whitworth Creek, the watershed at Blaisdell and the watershed at the Day Use Area. These hydrographs consist of miscellaneous instantaneous flow measurements (see Base Flow section).

Examination of these hydrographs yielded several observations. Peak flows were earliest and most pronounced in the watershed main stem. The majority of the flow in the watershed occurs in a three month period from April through June. The ratio of the highest peak flow to lowest base flow is 67:1 at watershed Blaisdell, 42:1 at the watershed Day Use Area, 23:1 at Brownsworth Creek and 102:1 at Whitworth Creek. While the other sites exhibited a "flashy", peak flow hydrograph, Brownsworth Creek exhibited a gradual, slowly increasing peak flow hydrograph.

The USGS performed a Log Pearson Type III analysis for the gaging station in the Sprague River near Beatty. According to this analysis, the Sprague River near Beatty experienced a 5 year flood event in 1993. Flow data is available for Brownsworth Creek, Whitworth Creek and the Day Use Area sites for 1993. Table HYD-2 lists the peak flow measurements recorded in 1993 and the calculated 5 year peak flows for these subsheds.

Table HYD-2
Measured and Calculated 1993 5-Year Peak Flows

		Peak Flows	
Subshed	Stream	Measured	Calculated
A	Brownsworth Creek	46 cfs	15 cfs
C	Whitworth Creek	39 cfs	17 cfs
Z	S.F. Sprague Day Use Area	340 cfs	646 cfs

Five Year peak flows were calculated for Brownsworth Creek and Whitworth Creek using the methodology outlined in Lohrey, 1982. Five year flow in the watershed at the Day Use Area was estimated using a USGS publication: Magnitude and Frequency of Floods in Eastern Oregon. The USGS publication was used for the watershed main stem because the method outlined in Lohrey is applicable to basins from 2.2 to 30 square miles in size (the watershed above the Day Use Area site is about 120 square miles).

It should be noted that the measurements listed above may or may not represent the actual peak flow occurring during 1993. These measurements were taken during the period in which peak flow occurred; actual peak flows could have been larger than what is listed in Table HYD-2. In addition, the calculated peak flows were derived from models and not from a rigorous statistical analysis such as Log Pearson Type III which would require about 10 years of annual peak flow information to compute.

The Klamath Basin Adjudication Team calculated 2 year return flows for three sites in the watershed. The Team used measurements of actual flow at bankfull conditions to derive these estimates. The watershed at Brownsworth has an estimated 2 year return flow of 150-175 cfs; the watershed at the Day Use Area, 220-240 cfs; and Brownsworth Creek, 30-40 cfs. These measurements provide a comparison to measured and calculated 5 year return flows in the watershed.

Assuming that the models used are valid, it is likely that peak flows have increased in Subsheds A and C. Peak flows in Subshed Z have apparently not increased, but this may be because increased peak flows in the other, tributary subsheds are not synchronized. The hydrographs appear to support this conclusion as there are variances in the timing of peak flows between subsheds. However, drainage basin shape, longitudinal profile and aspect all can influence the hydrograph and will interact with management activity effects to change the timing and amount of peak flows.

Roads are often a major impact on the hydrology of a watershed. The following is an excerpt from a memo written by the Forest hydrologist from the Kootenai National Forest that summarizes road impacts on peak flows:

"Roads are basically a horizontal feature in a landscape driven by vertical, gravity-driven processes. Spring snowmelt and runoff that would normally travel in a downhill direction, usually as shallow sub-surface flow, is intercepted by the compacted roads and their ditches and becomes surface flow. By doing this they are, in effect, dramatically increasing the drainage efficiency of a watershed. Increasing the drainage efficiency of a watershed concentrates flow so that peaks are higher..."

The drainage densities of the four subsheds in the watershed *(see* Introduction to Issue #1) as calculated by GIS are remarkably similar: roughly 1.6 miles per square mile for each. Table HYD-3 lists the road density of each subshed and the correlating hypothetical percent increase in drainage efficiency that the road density represents.

Table HYD-3
Road Density and Increased Drainage Efficiency by Subshed

Subshed	Drainage Density*	Road Density*	Increase in Drainage Efficiency
A	1.6	2.9	181%
B	1.6	4.3	269%
C	1.8	4.0	222%
Z	1.6	2.2	138%

* stream and road densities are miles per square mile.

Road densities in Subshed Z are likely underestimated, due to the lack of GIS data for private, nonforested land in that subshed.

It is likely that peak flows in the watershed watershed have been increased by synchronization of flow and increased drainage efficiency by roads. Compaction of soil through harvest activities has likely added to these effects. Apparent increases in flow are most pronounced in Subsheds B and C. The hydrographs corresponding to these subsheds support this conclusion. Peak flows in Subshed A have likely been increased partly due to vegetation removal from wildfire, but to a lesser extent, the hydrograph corresponding to this subshed shows moderated peak flow levels. These moderated peak flows may be caused by the orientation of the watershed (north-south) which could slow the rate of snow melt, or there may not have been enough measurements made to create an accurate hydrograph.

Peak flow in Subshed Z may be increased to some degree, although the cumulative effect of the other three subsheds may help to reduce or cancel out any peak flow increases in the lower portion of the watershed watershed.

Cumulative Effects Analysis

Removal of large areas of vegetation through timber harvest has the potential of increasing the timing and quantity of water runoff. Creating forest openings through timber harvest changes the aerodynamics of the vegetation, which can cause more snow to be deposited and accumulated on the soil surface. The magnitude of any change is the result of a variety of factors, including the intensity of the harvest, vegetation type, and the physiographic and climatic conditions.

The calculated equivalent clearcut area (ECA) value represents the total acreage of forested land within a watershed considered to be in a clearcut condition in terms of hydrologic response. The ECA includes the area of clearcuts and roads plus an ECA for partial cuts, overstory removals, selective cuts and commercial thinnings. Treatment factors are used to convert non-clearcut harvested areas to equivalent clearcut acres. "Recovered" in this analysis *is* considered to be "hydrologically recovered".

Harvest units are considered to be hydrologically recovered when re-establishment of leaf area is sufficient to return transpiration rates to pre-harvest levels and canopy closure is sufficient to prevent excessive snow loading. Leaf area index is the ideal variable to quantify recovery; however, due to data limitations canopy closure is used as a surrogate.

The Cumulative Watershed Effect (CWE) assessment method used by the Fremont NF determines the level of impact to a watershed by the percent of crown closure *as* compared with an undisturbed condition. The impacts of harvesting are separated into two groups: units that were harvested in the past 10 years (low vegetation is not fully recovered from disturbance) and units that were harvested more than 10 years ago (a fully occupied ground vegetation layer is present). The latter group is assigned an additional 50% decrease in impact to account for ground vegetation recovery. The percent of a clearcut that a partial cut represents *is* multiplied by the unit acreage, yielding impacted acres for treatments within the past 10 years, with an additional 50% reduction in those impacts for older treatments. The Clearcut Equivalent equated to various percentages of crown closure resulting from partial cuts has been assigned as follows:

Crown Left	Clearcut Equivalent
80-61%	15%
60-41%	50%
40-21%	70%
20%	85%

Crown closure is usually determined through examination of aerial photos or satellite images and assigning values to harvest units. Due to the size of the watershed and data and time constraints, broad generalizations were made about the relation of canopy closure to condition class (as mapped during the Assessment process). The following Clearcut Equivalent relations were used:

- Stands classified as post/poles to small or immature sawtimber 70% clearcut equivalent;
- Stand classified as seedlings, saplings or currently non-stocked but capable of producing timber – 100% clearcut equivalent;
- Roads 100% clearcut equivalent.

A Condition Class map was produced during the assessment that reflects assumed vegetative stand conditions in 1947. Although harvest activity did occur prior to 1947, data on those actions is not available for this watershed. Therefore, 1947 will be considered "historic" condition in this CWE analysis. Because of the lack of data, comparisons to a "natural" (unaltered by Euro-american activity) condition cannot be made.

To assess whether the use of a recovery factor would greatly reduce calculated current ECA levels, the Condition Class map was overlain with the Current Disturbances map (see Issue #1 for a description of the latter map). The Current Disturbances map was created in 1994. There is a high correlation between areas given a high disturbance rating and areas contributing towards ECA. Thus, these areas have not recovered to the extent that a 50% reduction in ECA is warranted for areas harvested more than 10 years ago. See Map HYD-1 for areas of high hydrologic impact..

The majority (98%+) of the SF Sprague River watershed lies above 4,500 feet. Above 4,500 feet, rain-on-snow events are less likely to occur except on infrequent occasions. Because rain-on-snow events are infrequent in the watershed watershed, cumulative watershed effects related to these events were not considered in this analysis.

Table HYD-4 summarizes the ECA present in 1947 and in 1994 by subshed. ECAs were calculated from available GIS data regarding road densities and acres of forest vegetation in various condition classes (posts/poles, seedlings/saplings or nonstocked). See Map HYD-2 for areas contributing to 1994 ECA levels.

Table HYD-4
Equivalent Clearcut Acres for forested acres

Subshed	1947 ECA	%	1994 ECA	
A	436	4	5,774	49
B	712	5	4,942	33
C	1,502	11	4,102	30
Z	2,751	16	12,658	74

*Percent of the forested acres in each subshed considered to be in Equivalent Clearcut condition. Non-forested lands are not included in this calculation, although poor conditions on these lands can contribute to adverse cumulative effects.

The Forest Plan addresses CWE in its Forest-Wide Standards for Watershed Management. The Forest Plan specifies that a CWE assessment consider an area no longer impacted when stocked with trees averaging, at a minimum, six feet in height and in sufficient numbers to provide 60% crown cover to the site. The CWE method described above seeks to improve on the CWE process outlined by the LRMP. However, due to an inability to distinguish areas on the Condition Class map that were treated more than 10 years ago, no recovery factor was considered in this analysis. Thus, the calculated number of CEA could be somewhat higher than what would be calculated using the new CWE method. However, as discussed previously, due to high hydrologic impacts having occurred on much of the area contributing towards ECA recovery could be minimal. The analysis in this report more closely approximates the method used in the Forest Plan.

The SF Sprague watershed was assigned a watershed impact limit of 35% in the Forest Plan. Only a portion of the watershed is covered in this analysis (82,100 acres of a total 156,300 acres). Of the acres included, 48% of the suitable forested acres are considered to be ECA. If this trend extends to the remaining acres, it is likely that the watershed limit has been *exceeded* even after accounting for recovery. It is also noteworthy that Subsheds A and B contain wilderness; thus, these areas serve to reduce the apparent level of ECA in these watersheds. If only the forested acres available for harvest are considered, then the percent of the watershed in ECA is even higher. Calculated ECA levels in Subshed C may be lower than actual levels due to the lower quality of data available on private land in that subshed.

Summary

Base flows in the watershed watershed have been reduced by drought and exacerbated by management activities resulting in poor channel and riparian condition in certain areas. Reductions in evapotranspiration from vegetation removal have occurred but may be offset by the invasion of white fir and increased stand densities in portions of the watershed. Peak flows have likely been increased, due to levels of harvest (removing vegetation canopy and compacting of soils) and an extensive road network. The increase in peak flow is not *as* apparent in the lower watershed, due to the non-additive nature of peak flows from tributary subsheds.

The timing of peak flows has also been likely altered, in that the duration of high flows is probably shorter and, in south-facing portions of the watershed, earlier in the year due to more rapid snowmelt from openings in the forest canopy. The increased drainage efficiency in the watershed allows for precipitation to quickly leave the watershed *as* surface flow rather than allowing it to percolate into the soil. In addition, poor channel and riparian conditions along various sections of streams in the watershed cause streams to act like canals transporting water out of the watershed instead of sponges soaking up water and releasing it slowly. These effects, when combined with irrigation diversions, serve to reduce base flows and exacerbate poor water quality conditions. The high levels of ECA in all subsheds may mean increased water yield, but without a means to retain it in the watershed, the net effect is for these increased yields to leave the watershed in higher, shorter peak flow periods during snow melt. Thus, less water remains to contribute to base flow later in the season.

Desired Condition

Instream and consumptive water rights are secured sufficient to carry out Fremont NF programs. Recommended monthly instream flows for the SF Sprague are being met.

Instream flows on all perennial streams in the SF Sprague watershed are sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows is being protected.

Overall, the watershed is in properly functioning condition. Precipitation is captured, stored, and safely released to springs and streams.

Current peak flow and base flow conditions are likely to continue into the future at or near current levels. Peak flows could be reduced and base flows increased over the long term if significant levels of road obliteration occur, particularly those roads that cross or are in close proximity to *streams.* As forest vegetation matures in the long term, use of water for transpiration will increase. However, it is likely that stand densities will be managed to mimic historic conditions wherever possible, and that currently overstocked stands will be treated to reduce stand densities to sustainable levels. Stream channel and riparian conditions will remain static in the short term and will slowly improve over the long term. If a large wildfire or flood event occurs in the watershed, then peak flow and base flow levels would change in response to large scale removal of vegetation or greatly reduced stream channel and riparian area function.

Issue #4: Management activities have modified aquatic/fish habitat conditions and caused changes in TES Species (redband trout, bull trout, shortnose/Lost River Klamath large scale sucker, and Chinook salmon) distribution and populations.

Key questions

1. Have aquatic/fish habitat abundance and conditions, and aquatic system processes and flows been altered?

   Parameters: past and present conditions and connectivity; fish composition, distribution, and populations; and location of key refugia or hotspot habitat for TES species.

2. Have management activities affected aquatic/fish biodiversity, community, composition, and distribution, and populations; especially fragmentation of fish species populations, which threatens species viability?

   Parameters: large woody debris, pool habitat, bank stability, streamside cover and substrata composition, depth ratios, fish species composition, distribution and populations.

3. Where are the known problem areas that are contributing to reduced fish habitat capability?

   Parameters: location of management activities and natural events affecting fish habitat.

   Stratification

The fish habitat analysis was stratified by reach and by stream. Streams which exhibited variation between headwater areas and lower reaches were stratified into upper and lower reaches. These stratifications were based on stream channel type, shading, riparian vegetation, stream bank stability, large woody debris and aquatic habitat condition. This level of stratification was selected because it provided more site specificity than by subshed.

Fish distribution was stratified to help qualify the status of species presence/absence within stream reaches. Species presence stratification included: occupied, unknown and potential.

Watershed

Historic Condition

Conditions in the Sprague River Valley and the SF Sprague downstream from the analyis area have changed since settlement by European man. Laurence (1934) traveled the Sprague River Valley in 1919 and reported large stands of mature quaking aspen from above Beatty to an undefined location upstream from Bly. This would have included the lower reaches of the SF Sprague River (watershed) downstream from the National Forest boundary. Other riparian species reported were willow, service berry, choke cherry, rose, golden current, bunch berry and stinging nettle. By 1919, the valley had been developed "extensively for agriculture".

When Laurence revisited the valley in 1934, he reported a total lack of trees and willows downstream of Beatty and stated that was in "marked contrast" to conditions upstream from Beatty. In addition, Laurence reported aspen were seen to be dead along the river. Spiers (1930) in Dambacher 1995, stated that the Klamath Indians utilized suckers, rainbow trout, spring and fall runs of chinook salmon as food. Spires also reported chinook salmon migrated upstream as far as Yainax. Because of the similarities of the Sprague between Yainax and Bly, with downstream reaches, it is likely that chinook may have used portions of the watershed and NFS in the Bly vicinity. There are anecdotal reports of Lakeview residents traveling to Bly in the early 1900's to fish for salmon (Wenzel, pers. comm. 1995). Local citizens reported salmon spawning in the upper Sprague from August through November (Fortune et. al. 1966). In the same report, Fortune stated "Salmon were reported to have spawned in the Sprague in the vicinity of Beatty, upstream on the south fork past Bly to the headwaters and on the north fork as well".

Historic riparian conditions in the watershed within the analysis area were likely to have included pine and white fir old growth overstory, a dense understory of alder, willow, red osier dogwood, aspen and other riparian species. In addition, there were localized stands of cottonwood. For further information, refer to the Riparian Ecosystem Module. Aquatic habitat conditions were characterized by having low levels of stream bank instability, low width to depths, large amounts of LWD in canyon reaches and low amounts of LWD in meadow areas (Blaisdell and areas upstream from the watershed/34 road crossing). Aquatic habitat was complex and had numerous large, deep pools. Pools were likely deeper than 3 feet and had low levels of fine sediment. Spawning substrate was well distributed and was trapped in large pockets by LWD accumulations. The spawning gravels were very high quality because of the low levels of sediment. Fish species which were likely present included the bull trout (resident and fluvial life histories), redband trout (resident and possibly fluvial life history), shortnose and Klamath large scale suckers, marbled sculpin, lampreys, chinook salmon, possibly steelhead, tui chubs and speckled dace.

Historic riparian conditions in the tributaries of the watershed are likely to have included dense stands of riparian shrubs with an overstory of ponderosa pine. In some areas it is likely there were fir (pine associated stands) overstories with riparian shrub understories. In areas with flood plain widths of less than 100 feet, it is likely that the shrubs were concentrated along the streambanks. It is also very likely there were meadow areas with only willows and/or aspen present along the stream banks. For further information on riparian conditions refer to the Riparian Ecosystem module.

Aquatic habitat conditions were likely to have been similar to those in the mainstem watershed. Tributary flows would have been lower than in the mainstem watershed so pools would likely be shallower. Aquatic habitat conditions were characterized by having low levels of stream bank instability, low width to depths, large amounts of LWD in canyon reaches. Aquatic habitat was complex and had numerous pools. Spawning substrate was well distributed and was trapped in large pockets by LWD accumulations.

Current Condition

Today conditions on private lands in the Sprague River Valley downstream from the analysis area have changed. In the early part of this century, parts of the Sprague River were modified for floating logs (Spires 1930 in Dambacher 1995).

This data indicates that while temperatures in the upper mainstem of the watershed are not limiting to native fish species during cool, wet years, their temperature profile during warm, dry years is not at state standards or desired condition. Since the watershed and lower Corral Creek have meadows that are grazed as part of the Pothole Grazing allotment and riparian shrubs are not at desired condition, trend analysis of riparian shrubs in this part of the river is necessary to set grazing policy on these stream reaches. Static or downward trend would indicate the need for grazing strategy changes if native fish species are to be perpetuated or reestablished.

In addition, water temperature problems are additive, therefore, temperatures downstream (between the Camp Creek confluence and Blaisdell Creek) will not be moved closer to desired condition until water temperature problems in the upper river are resolved.

Temperatures in the lower reaches and tributaries do not meet the desired condition (SF Sprague river below Blaisdell Creek, including Brownsworth, Ish Tish, and Paradise Creeks). Ish Tish and Paradise Creeks enter the SF Sprague river on private land and are likely to be intermittent. Because they enter the river on private land and there is no data, they will not be discussed. The watershed below Blaisdell has exceeded state temperature standards each year since 1990. Temperatures have exceeded state standards during both warm and cool years, during high flows and low. The 7 day average temperature exceeded 58°F from a high of 14 weeks in 1992 to a low of 6 weeks in 1994.

The upper reaches of Leonard and Brownsworth Creeks on Fremont NF lands and within bull trout habitat are within state temperature standards. Conditions become borderline for bull trout survival as you travel downstream. The lowest reach of Brownsworth Creek experiences temperatures too high to support bull trout.

<u>Desired Condition</u>

Fish Populations

The desired conditions for fisheries in the watershed watershed are to: 1) maintain or increase all populations of native fish, 2) reduce populations of non-native fish (brook and brown trout) in historic bull trout habitat, and 3) re-establish bull trout throughout their historic range within the watershed to help meet recovery goals for all TES species, and to reflect the inherent productive capacity of the habitat for native fish species.

The watershed is designated a key watershed as part of a network of key watersheds in the Klamath Basin crucial for maintaining viable bull trout populations in the basin.

Native Fish Populations - Bull Trout

Isolated, resident bull trout populations in the headwater reaches of Brownsworth and Leonard Creeks are secured by expanding their distribution and numbers throughout the entire length of Leonard Creek and Brownsworth Creek to its mouth. These two streams are designated as refugia or anchors for the restoration of bull trout to historic habitat in the watershed. Bull trout populations are established thourghout the historic habitat in Camp and Corral Creeks and headwater reaches of the SF Sprague mainstem.

Isolated, fragmented, resident bull trout populations in adjacent headwater tributaries to the watershed are connected to re-establish a watershed fluvial sub-population (meta-population) in the Sprague River basin. Fish passage is adequate in all fish bearing streams.

Redband Trout

Population abundance and distribution of redband is the same as presently exist in the watershed.

Non-native Fish Populations

Brown Trout

Brown trout populations are absent in the middle reaches of Brownsworth Creek and the lower reaches of Leonard and Hammond Creeks, and the SF Sprague ma ins tem.

Brook Trout

Brook trout are absent in Camp and Corral Creeks and headwater reaches of the SF Sprague mainstem.

Fish Habitat

General

Aquatic/riparian system is fully functioning with high water quality, adequate flow, and structurally diverse habitats. Production of fishery resources is sustained and TES species have recovered.

Stream temperature

Summer water temperatures are well within tolerances of all life stages of aquatic organisms historically found in the system. Temperature ranges provide for the best growth and survival, resistance to parasites and diseases, and competitive advantage to native fishes.

Summer rearing temperatures: Adults and juveniles 8-16^{o} C
Spawning and incubation 4- 9^{o} C

Stream shade

High plant species richness characteristic of native plant associations is found in the **riparian** zone. Riparian vegetation is abundant and well distributed within fluvial zones such as streambanks, active channel shelves, active floodplains, and overflow channels. Riparian vegetation provides stable undercut banks, overhanging vegetative cover, shade along the channel margins, narrow channel width and terrestrial insect drop. Where the potential exists, hardwoods dominate the area immediately adjacent to the stream channel while conifers dominate outer margins of the riparian area. The shade from riparian vegetation provides adequate summer/winter thermal regulation of stream water temperature.

Stream shading: 50-75% of stream surface area or
100% of site potential if potential is **less** than 50%

Habitat composition, pool habitat

Abundant pool space in a diversity of shapes, sizes, and depths is well distributed throughout the perennial streams at all flow regimes. Cover is present to provide refuges from drought, winter conditions, flood conditions and predation. Pool tails frequently provide clean spawning and rearing substrate.

Pools store nutrients for fish food production and sediment to buffer the effects of sediment pulses, but sediment deposition rates do not significantly reduce pool depth.

Pool frequency: 35-60% of stream surface area dependent upon channel gradient; low gradient reaches (C channels) at the lower end of the range, high gradient reaches (B and A channels) toward the upper end.

Pool quality: more than 30% of total pools with residual pool depth greater than 2 feet

Channel width to depth ratio

Narrow, deep channels are the characteristic morphological feature of all stream systems. These channels are frequently characterized by densely vegetated, stable and undercut banks, high pool frequency and quality, a well shaded stream surface, and high invertebrate food production. Water and sediment delivery, transport and storage are in dynamic equilibrium.

W/D ratio: A channels – lees than 12
B channels – less than 20
C channels – less than 20 E
channels – **less** than 12

Stream bank stability

Stream banks show little or no evidence of active erosion, breakdown, tension cracking or shearing. Undercut banks are common, generally, greater than 75% of the banks in non-forested systems. Stream banks support dense riparian vegetation or are well armored with large rock substrate.

Bank stability: at least 80% of banks are stable

Substrate/sediment

Coarse channel substrate in low gradient riffles and tails of pools are free of sand/silt deposits. Micro habitats among the interstitial spaces between coarse substrate **are** readily available to juvenile fish and macro invertebrates. Gravel permeability and suitability for spawning is good to excellent and egg/fry survival is high. Sediment delivery, transport, and storage through the system are in dynamic equilibrium and bedload deposition rates are minimal. Spawning habitat for the shortnose sucker in the Sprague River *system is* 51% cobble and 49% gravels (Bienz and Ziller 1987).

Surface fines (sand/silt): B channels: 2-13%
C channels: 10-20%

Woody debris in stream channel

Stream channels in forested systems contain moderately frequent and well distributed complexes of logs, including single *pieces,* groups, and root wads. These complexes interact overtime and through a wide range of flows and climatic conditions to create a high diversity of aquatic habitat conditions, especially pool space and cover. The abundance and sizes of woody debris is sufficient to help maintain the dynamic equilibrium of sediment transport and storage in the system.

Woody debris frequency and size

Lodgepole pine and aspen stands: More than 50 pieces per mile (minimum 8" small end diameter and at least 35 feet in length)

Pine and pine associated stands: More than 60 pieces per mile (minimum 12" small end diameter and at least 35 feet in length

Land Use Effects, Condition Trends and Evaluation

Timber Harvest Effects

Logging increases sedimentation directly proportional to the amount of soil disturbed and the amount of compaction. Roads, road crossings, skid trails, landings, and disturbed ground within logged units can contribute large amounts of fine sediments to stream channels (Chamberlain et al. 1991). Applying the Forest Plan amendment, riparian buffers (300-foot no-cut buffers on all fishbearing streams; 150-foot no-cut buffers on all perennial non-fishbearing streams; and 100-foot no-cut buffers on all intermittent non-fishbearing streams) will reduce sediment inputs, retain shading and LWD recruitment potential.

Removal of forest vegetation alters the timing, duration, and intensity of spring runoff. Clear-cutting causes increased snow deposition in the openings and advances the timing of runoff. Snow melt can be accelerated by large energy inputs of warm rain falling on snow (Chamberlain et. al 1991). Rain on snow events such *as* happened during January - March 1995 in the upper Klamath Basin can have severe consequences for stream channel condition, instream habitat, and juvenile fish.

Bull trout spawn in the fall and the eggs/alvins spend much longer in gravel before emergence than other species of fish. This makes them more prone to redd scour and sedimentation. Redd scour occurs when high flows occur earlier than normal and before emergence of the alvins. High flows can disrupt the nest and wash the young alvins/eggs away causing very high mortality. These events are natural and have been happening for thousands of years. However, with reduced numbers, these events can have severe consequences on recruitment for the population as a whole. Watersheds with large amounts of hydrologically immature vegetation are more prone to redd scour during rain on snow events. Rain on snow events are generally infrequent in the upper Klamath Basin but some of the most severe high water events are attributed to rain on snow events. The watershed experienced 4 rain on snow events from January to March 1995. Whether redd scour occurred is unknown.

Redds can also experience dewatering. Dewatering is mostly a problem with spring spawning fish and then only when snow packs are small and streams experience rapid falling legs on the hydrograph. If this happens before the young alvins emerge from the gravels they will die. The incidence of redd dewatering in the upper watershed *is* unknown.

These upslope forest activities can have negative consequences for downstream channels already in poor condition. This is especially true in watersheds with a high percentage of hydrologically immature vegetation. Increases in peak flows can cause rapid bank erosion, formation of midchannel depositional bars, and increase width-to-depth ratios. These changes in habitat conditions reduce stream effectiveness as aquatic specie habitat. Forest management practices are a contributing factor in water quality problems in the Klamath Basin (USFWS 1993). Increases in sediment in sucker habitat can affect the quality of spawning substrate.

Grazing Effects

Livestock grazing can affect the riparian environment by changing, reducing, or eliminating vegetation and by causing lowering of the water table (Platts, 1991). Adverse modification of the stream channel can occur from hoof shear, trampling, browsing of shrubs, and grazing of grass and grass-like vegetation. As compared with ungrazed channels, grazed channels contain more fine sediment, stream banks have higher instability, banks are less undercut, and stream temperatures are higher. Severe trampling can compact soils to the extent where infiltration is reduced (Platts 1991).

Riparian shrubs and sedges protect stream banks from erosional forces, *as* well as providing habitat for fish and fish prey items. Detritus from riparian vegetation is an important food component for aquatic insects. Riparian shrubs and sedges add significant floodplain and stream bank "roughness". This roughness is beneficial during high water events, when streams overflow their banks and flood riparian vegetation.

Flood waters flatten riparian shrubs and vegetation into mats that decrease flow velocity and cause deposition of sediment, thereby building the stream banks and floodplain. Platts et. al. 1985, found that large flood events increased stream width by 40% on grazed reaches of a Great Basin creek. In contrast, a reach of the same stream rested for 10 years from grazing experienced a "slight increase in width" from the same flood events. In the same study, an ungrazed stream reach improved habitat condition during the same large storm events because its riparian vegetation protected its banks from the high flows. Wersche et. al. 1985, reported overhead bank cover had the most statistically significant affect on trout populations.

Stream side vegetation was found to provide 50% of the streams nutrient energy supply for the food chain (Cummins 1974 *as* reported in Platts 1991). Riparian vegetation also is very important in protecting streambanks from anchor ice events and preventing the formation of anchor ice. Grazing removes streambank vegetation, which can decrease the streambank armoring and increase the likelihood of streambank erosion and anchor ice events (Platts 1991). Clary and Webster (1989) reported that the primary cause of riparian shrub reduction was livestock browsing of young reproductive classes. Season-long grazing has been demonstrated to be incompatible with increasing riparian willow stands (Elmore and Kovalchik 1991).

Willow cover in an ungrazed area within a livestock exclosure was found to provide 75% more shade to the stream than was found in the adjacent grazed area where willows were *less* abundant (Claire and Storch *as* reported by Platts 1991). Spring grazing has been found to have no effect on stream channel morphology; however, summer and fall grazing increased the stream channel width (Siekert et. al. 1985). Increasing stream width increases the amount of surface area available to absorb sunlight and decreases water depth and quality of fish habitat.

STREAM AND REACH
South Fork Sprague Mainstream

Historic Condition (Lower and Middle Reaches)

Conditions in the unsurveyed lower reaches of the watershed (private lands in the Sprague River Valley) were discussed under the historic summary section of this document. The stream type was likely *a* Rosgen C or E channel. Suckers, fluvial bull trout, and salmon were likely to have used these lower reaches at different times of the year.

The lower reaches (surveyed Fremont NF lands within the watershed canyon) ha• mature and overmature pine and pine associated conifers present within the riparian area and deciduous riparian species such as mountain alder, red osier dogwood and willow. The shading effect created by the large conifers and deciduous species was likely to have shaded the stream surface 80% or more. Alder were possibly fewer in number along the stream banks than currently, especially in the portion of the canyon burned in the Round Butte Fire of 1958. LWD levels were likely much greater than currently exist based on relatively pristine conditions found further upstream. Fluvial bull trout were present in the lower reaches during the winter and spring moving into the headwaters and tributaries during the late summer and fall for spawning. Redband trout, lampreys and marbled sculpin were also present.

The middle reaches include mostly private, non forested, meadow areas that were predominately willow vegetated. These private portions not surveyed. These reaches were unlikely to have large levels of LWD but had moderate shading, high stream bank stability, and lower water temperatures than currently found there. In channel sediment levels were also likely to have been lower because of the intact riparian vegetation/floodplain and high stream bank stability. The canyon portions of this reach were likely to have large amounts of LWD, high amounts of stream shade and deep, complex pools. Bull trout (fluvial and resident), redband and lampreys were present.

Current Condition (Lower Reaches)

The lower reaches (private) were not surveyed but portions visible from the 34 road generally have low stream bank stability, low shading and high width to depths. Rosgen channel type is an F.

The lower reaches of the watershed (Fremont NF lands) are F and B channel types with width to depth ratios up to 20, average stream shading 6%, pool habitat frequency of 41% of surface area, average residual pool depth of 1.8 feet deep, stream bank stability averaging 68% stable, and 14 pieces of LWD per mile. Fine sediment is present in levels greater than 35%. Fish species occupying these reaches are: brown trout, tui chub, speckled dace and sculpin. It is also likely that there are lampreys present, however, none have been observed.

In 1928, coastal stocks of rainbow trout were stocked in the watershed. That first year 54,000 fish were stocked. It is believed the fish stocked were fall spawning fish, therefore, it is possible low levels of hybridization occurred between the hatchery fish and the spring spawning native redband.

Land Use Effects, Condition Trends and Evaluation

The lower reaches (Fremont NF lands) do not meet desired conditions. Stream shading, stream stability, and LWD fall far short of desired condition. Projects addressing these problems should be a priority for this reach of stream. If recommendations of the draft bull trout conservation strategy are followed and the lower canyon riparian areas are excluded from grazing until riparian recovery has been initiated, habitat condition will improve, aquatic habitat sedimentation will decline (due to the reduction of problem roads and stream bank instability), and habitat effectiveness will improve for native fish species including bull and redband trout.

If problem roads are not obliterated and revegetated, if projects are not undertaken to increase the amount of coniferous and deciduous shade in the riparian area, and if grazing further reduces riparian shrubs from riparian areas; habitat condition will continue to decline, sedimentation will continue' unabated and native salmonid habitat will decline further. This may prevent the recovery of fluvial life history bull trout in the watershed *as* well as reestablishment of resident bull trout in lower Brownsworth Creek.

Historic Condition (Upper Reaches)

In the upper reaches, Rosgen B stream channels were similar to conditions today. Large amounts of LWD, high amounts of shading, low width to depth ratios and deep, complex pools were present in levels consistent with the desired condition. Those reaches in the high elevation meadows had high amounts of willows, Rosgen E channel types, very low width to depths, and high stream bank stability. Bull and redband trout and lampreys were present.

Current Condition (Upper Reaches)

The upper reaches of the SF Sprague River (Fremont NF lands) are B, C, and E channel types with width to depth ratios up to 23, average stream shading of 40%, pool habitat frequency of 35% of surface area, average residual pool depth of 1.1 feet deep, stream bank stability unknown but likely >50% stable, and 55 pieces of LWD per mile. Sediment is present in levels greater than 35% for 3 of the 4 upper reaches. Brook, brown, and redband trout are present with brook occupying the extreme headwaters exclusively and brown and redband found at the lower elevations.

Land Use Effects, Condition Trends and Evaluation

The upper reaches of the watershed do not meet desired conditions for stream shade and sediment. The upper reaches include a deep canyon with nearly pristine habitat conditions and high elevation meadows. These meadows have experienced heavy grazing in the past and have much lower levels of shrubs than existed historically. In the canyon, LWD, shading and width to depth are likely at or near historic conditions. The upper meadow areas are naturally low in LWD, therefore, skewing the LWD per mile figures.

Levels of LWD are higher than the LWD per mile figures indicate. Elevated sediment levels are likely a result of roads and logging in the uplands and areas adjacent to the creek *(see* logging effects section). The reestablishment of bull trout to the upper reaches will also require reduction of sediment levels.

Recovery of the upper reaches of the watershed will not occur unless meadows are managed to restore stream bank stability, shading, and width; recommendations of the draft bull trout conservation strategy are followed; and roads causing habitat sedimentation are obliterated and revegetated. If implemented, these measures will improve aquatic habitat quality for the aquatic ecosystem including bull and redband trout.

Brownsworth Creek

Historic Condition

The conditions in the lower reaches of Brownsworth Creek were much different than today (see riparian habitat module). Mature and overmature pine and pine associated conifers lined the riparian area in combination with deciduous, riparian species such *as* mountain alder, red osier dogwood, and willow. The shading effect created by the large conifers and deciduous species was likely to have shaded the stream surface up to 80%. It *is* possible alder were fewer in number along the stream banks. LWD levels were likely much greater than currently exist.

Width to depths were low, stream bank stability was high, deep, complex pools were frequent and fine sediment was low. Fluvial bull trout were present in the lower reaches during the late summer and fall for spawning. Resident bull and redband trout were present year-long. Lampreys and marbled sculpin were also likely to have been present.

The upper reach and Weyerhaeuser land downstream to the 34 road crossing had higher LWD levels, shading, and lower sediment levels. Historic habitat conditions within the Wilderness are similar to current conditions. Resident bull trout were present year long. Resident redband trout were present in the lower portion of reach 4 also.

Current Condition

The lower reaches of Brownsworth Creek are Rosgen C and B channel types and generally have a width to depth ratio of 12, stream shading of 60% or less, pool habitat frequency of 17% of surface area, pools averaging 1.1 foot residual depth, stream bank stability of 75% (with localized areas of stream bank instability), and spawning substrate with >35% fine sediment (embeddedness). LWD was present at 2 pieces/mile of stream. The Round Butte Fire of 1958 ran up the Brownsworth Creek canyon and burned all vegetation including that within the riparian area. Subsequent salvage logging removed the potential LWD and may have removed some existing inchannel debris as well. This fire eliminated all riparian conifers for the lower half. This burn occurred on both Fremont NF and private lands. Sympatric populations of brown and redband trout and lampreys inhabit the lower reaches.

The upper reach *is* a Rosgen B tending to A in the extreme headwaters. Width to depth ratios are unknown but are thought to be less than 10, stream shading is 75% or greater (with more "opaque" shade provided by the conifer overstory than that present in the lower reaches), pool habitat frequency of 17% of surface area, pools averaging .7 foot residual depth. Stream bank stability *is* greater than 75%. The upper reach is occupied by resident bull trout.

Land Use Effects, Condition Trends and Evaluation

The lower reaches of Brownsworth have been negatively affected by the Round Butte Fire, salvage logging, and past grazing. Width to depth ratios, shading, and stream bank stability are fair to good. Sedimentation is high and has reduced the amount of high quality spawning habitat over historic levels. Following the Round Butte Fire the riparian area did not provide adequate shade or LWD recruitment to the stream. It is likely that for several years afterward stream water temperatures and inchannel sediment levels increased greatly.

These may have been the dominant factors in the elimination of bull trout from this reach. Currently, populations of brown and redband trout and a lamprey species occupy these reaches.

Recovery of the lower reaches of Brownsworth Creek will not occur unless the riparian areas are managed to restore stream bank stability, shading, and width; recommendations of the draft bull trout conservation strategy are followed; and roads causing habitat sedimentation are obliterated and revegetated. If implemented, these measures will improve aquatic habitat quality for the aquatic ecosystem including bull and redband trout. If not implemented aquatic habitat conditions will decline or remain static and restoration of bull trout to lower Brownsworth will not occur.

The upper reach of Brownsworth is in relatively pristine condition. Some sedimentation is present from past logging but the riparian buffers used partially protected the habitat from sedimentation while retaining LWD and shade. Protecting existing habitat from degradation should be adequate to retain existing habitat.

Leonard Creek

Historic Condition (lower reach, Weyerhaueser)

The conditions in lower Leonard Creek were much different than today (see riparian habitat module). Mature and overmature pine and fir were present within the riparian area along with deciduous riparian species such as mountain alder and willow. The shading effect created by the large conifers and deciduous species were likely to have shaded the stream surface up to 80%. Alder was likely fewer in number along the stream banks, especially in logged sections. Large amounts of LWD, high amounts of shading, low width to depth ratios and deep, complex pools were present in levels consistent with desired condition. Resident bull and redband trout were present.

Current Condition (Lower Reach)

The lower reach (private land) was not surveyed but has moderately good stream bank stability, moderate shading and low width to depth. Fine sediment is present in levels greater than 35%. Rosgen channel type is *a* C. Resident redband and small numbers of resident bull and brown trout are present.

Historic Condition (Upper reach)

The conditions in Fremont NF portions of Leonard Creek were similar to conditions today (see riparian habitat module). Mature and overmature pine and fir were present within the riparian area along with deciduous riparian species such as mountain alder and willow. The shading effect created by the large conifers and deciduous species were likely to have shaded the stream surface up to 80%. Large amounts of LWD, high amounts of shading, low width to depth and deep, complex pools were present. Sedimentation was low. Resident bull trout were present.

Current Condition (Upper Reach)

The upper reach of Leonard Creek are B, C and A channel types with a width to depth of up to 10, average stream shading of approximately 80%, pool habitat frequency of 7% of surface area, average residual pool depth of .7 feet deep, stream bank stability is 98% stable, and an average of 396 pieces of LWD per mile are present. Sediment is present in levels less than 35% for the upper reach but large amounts of sediment are entering the stream from roads and being transported downstream. Resident bull trout are the only fish present.

Land Use Effects, Condition Trends and Evaluation

The upper reach meets the desired condition for most habitat attributes. The amount of pools present and the residual pool depths are low which indicate possible filling from pool sedimentation caused by roads and past clearcut logging. The gradient is also high making it likely sediment is being transported and filling pools. Problem roads in this area add large amounts of sediment to this part of the stream annually.

In addition, 3 culverts on Leonard Creek are barriers to bull trout migration during part of the year. To allow for unrestricted movement by the small number of bull trout remaining, they should be modified or removed at the *same time* the road is obliterated.

Recovery of the upper reach of Leonard Creek will not occur unless the problem roads are obliterated and revegetated, riparian areas are managed to restore stream bank stability, shading, width, and recommendations of the draft bull trout conservation strategy are followed. Without the road obliterations it is likely bull trout populations will become non-viable. If implemented, these measures will improve aquatic habitat quality for the aquatic ecosystem including bull and downstream populations of redband trout. If not implemented aquatic habitat conditions will decline or remain static and restoration of bull trout to lower Leonard and Hammond Creek will not occur.

Hammond Creek

Historic Condition (Weyerhaeuser)

Same as Leonard Creek.

Current Condition

Hammond Creek is *a* tributary to Brownsworth Creek. Leonard Creek is the main tributary to Hammond Creek. The whole length of Hammond Creek runs through private lands (Weyerhaueser) with C and B channel types with a width to depth ratio of up to 7, average stream shading of approximately 60%, pool habitat frequency of 18% of surface area, average residual pool depth of 1.0 feet deep, stream bank stability *is* 75% stable (with some localized instability from livestock), and 138 pieces of LWD per mile are present. Sediment is present in levels greater than 35%. Resident brown and redband trout are present.

Land Use Effects, Condition Trends and Evaluation

Sedimentation from roads and road crossings are likely the source of most of the sediment. Some skidding from past logging adjacent to the riparian may may have contributed to existing sedimentation levels. An intermittent tributary to Hammond Creek (may have been perennial at one time) *is* also a major contributor of sediment. This tributary is not on Fremont NF land. Upstream roads in Leonard Creek subshed are also likely contributors to sediment levels.

A portion of Leonard Creek is managed by the Fremont NF and reducing sediment' imputs *is* very likely to improve sediment levels in Hammond Creek. Cooperative road obliterations and habitat restoration actions between Weyerhaeuser and Fremont NF are possible and desirable. In addition, the actively eroding, intermittent tributary to Hammond Creek was identified by Weyerhaeuser biologists as a sediment source.

Recovery of habitat in Hammond Creek will not occur unless the problem roads in Leonard Creek are obliterated and revegetated, riparian areas are managed to increase stream bank stability, shading, maintain width, and recommendations of the draft bull trout conservation strategy are followed.

Camp Creek

Historic Condition (Lower Reach)

The conditions in Camp Creek were similar to today (see riparian habitat module). Mature and overmature lodgepole pine were present within the riparian area along with deciduous riparian species such as mountain alder and willow. Large amounts of LWD, high amounts of shading, low width to depths and deep, complex pools were also present. Sedimentation was low. Resident bull and redband trout were present. In 1969, bull trout were caught in Camp Creek near the Wilderness boundary (Charlie Phillips, pers. comm. 1992).

Current Condition (Lower Reach)

The lower reach of Camp Creek is a C channel type with a width to depth of up to 9, average stream shading of approximately 55%, pool habitat frequency of 16% of surface area, average residual pool depth of 1.1 feet deep, stream bank stability is 90% stable, and an average of 41 pieces of LWD per mile are present. Sediment is present in levels less than 35%. Resident brook trout are present.

Land Use Effects, Condition Trends and Evaluation

The lower reach meets the DC for most habitat attributes. The amount of pools present and the residual pool depths are low which indicate possible filling from pool sedimentation caused by logging and roads. Grazing has reduced the amount of willow and lowered the stream bank stability in the low gradient meadow part of the reach near the confluence with the SF Sprague River. This creek has been proposed for reintroduction of the bull trout. To assure success, sedimentation problems caused by roads and grazing impacts to the confluence of Camp/watershed should be reduced.

Recovery of the lower reach of Camp Creek may require evaluation of road impacts and site specific plans for reducing sediment inputs. The lowest part of the reach (at the confluence) needs to be managed to restore stream bank stability, shading, and width. Above the 34 road, attempts should be made to reduce sedimentation by obliterating and revegetating roads. Camp Creeks thermal profile is among the best in the watershed, which would give it a better chance for re-establishing bull trout to their former habitat. Reestablishing bull trout in this formerly occupied habitat would require construction of a barrier at the 34 road crossing and removal of the brook trout currently inhabiting the creek. If implemented, these measures will improve aquatic habitat quality for. the aquatic ecosystem including bull and redband trout. If not implemented aquatic habitat conditions will decline or remain static and restoration of bull trout to lower Camp Creek may not be possible.

Historic Condition (Upper Reach)

Historically the conditions in Camp Creek were similar to today except for sediment levels (see riparian habitat module). Mature and overmature lodgepole pine were present within the riparian area along with deciduous riparian species such as mountain alder and willow. Large amounts of LWD, high amounts of shading, low width to depths and deep, complex pools were present in levels consistent with DC. Sedimentation was low. Resident bull trout were present. In 1969, bull trout were caught in Camp Creek near the Wilderness boundary (Charlie Phillips, pers. comm. 1992).

Current Condition (Upper Reach)

The upper reach of Camp Creek contain B channel types with a width to depth ratios up to 6, average stream shading of approximately 35%, pool habitat frequency of 44% of surface area, average residual pool depth of .7 feet deep, stream bank stability is 90% stable, and an average of 60 pieces of LWD per mile are present. Sediment is present in levels greater than 35% for the upper reaches. Resident brook trout are the only fish species present.

Land Use Effects, Condition Trends and Evaluation

The upper **reach** meets the desired condition for most habitat attributes. The amount of pools present are just out of desired condition range but could be acceptable given the headwater nature of the stream (low flows and small watershed area). The residual pool depths are low which could indicate filling from pool sedimentation caused by logging and roading or again reflect the small nature of the stream. In 1969, bull trout were caught in Camp Creek near the Wilderness boundary (Charlie Phillips, pers. comm. 1992). Given its favorable temperature profile, bull trout could be re-established in this stream. This is possible only if sedimentation sources are identified and rehabilitated.

Historic Condition (Lower Reach)

The conditions **in** Corral Creek were similar to today **(see** riparian habitat module). Mature and overmature lodgepole pine were present within the riparian area along with deciduous riparian species such *as* mountain alder and willow. LWD was present in levels slightly lower than current (some evidence of very old riparian logging is present), high amounts of shading, low width to depths and deep, complex pools were present in levels consistent with desired condition. Sedimentation *was* low. The lowest portion of this reach (meadow, E channel type) was heavily populated by willow. Resident bull and redband trout were present.

Current Condition (Lower Reach)

The lower reach of Corral Creek is an E channel type with a width to depth ratios up to 7, average stream shading of approximately 25%, pool habitat frequency of 44% of surface area, average, stream bank stability *is* 90% stable, and an average of 35 pieces of LWD per mile are present. Sediment is present in levels less than 35%. Resident brook trout are present. At least one brown" trout was present indicating the stream temperature may be on the threshold for brown trout invasion.

Land Use Effects, Condition Trends and Evaluation

The lower reach meets the desired condition for most habitat attributes. This is the only stream in the watershed that has all reaches <35% embedded with fine sediment. As such, it is a very important stream for the re-establishment of bull trout in the watershed. The amount of pools present and the residual pool depth ratios are high which is indicative of the E channel types. These channel types are very sensitive to grazing damage and are one of the most productive stream types for fish production. Grazing has reduced the amount of willow and therefore increased the amount of sunlight hitting the waters surface. LWD would not be expected to be frequent in the meadow under historic or current conditions.

This stream is an essential component in the restoration of bull trout in the watershed. To assure success, grazing utilization on shrubs should be closely monitored. The high stream bank stability on this channel type indicates current utilization on the meadow is not harming stability.

Recovery of the lower reach of Corral Creek will occur quickly if the riparian areas are managed to restore willow. Width and stability *is* already good and will respond rapidly. If restored, the meadow will make an already high quality piece of habitat better. If not implemented aquatic habitat conditions are likely to remain static.

Historic Condition (Upper Reach)

Historically the conditions in Corral Creek were similar to today **(see** riparian habitat module). Mature and overmature lodgepole pine were present within the riparian area along with deciduous riparian species such *as* mountain alder and willow. LWD was present in amounts slightly higher than today, high amounts of shading, low width to depths and deep, complex pools were present in levels consistent with DC. Sedimentation was low. Resident bull trout were present.

Current Condition (Upper Reach)

The upper reach of Corral Creek contains E channel types with a width to depth ratios up to 9, average stream shading of approximately 30%, pool habitat frequency of 22% of surface area, stream bank stability *is* 80% stable, and an average of 43 pieces of LWD per mile are present. Sediment is present in levels less than 35%. Resident brook trout are the only fish species present.

Land Use Effects, Condition Trends and Evaluation

The upper reach meets the desired condition for most habitat attributes. The amount of pools present is low but could be acceptable given the headwater nature of the stream (low flows and small watershed area). Since the embeddedness is <35%, it can be assumed the are no significant sediment sources along the length of stream. Because of the low amount of sediment present in the system and favorable temperature profile, this stream could support bull trout.

Buckboard Creek

Historic Condition

The conditions in lower Buckboard Creek were much different than today (see riparian habitat module). Mature and overmature Ponderosa pine and white fir were present within the riparian area along with deciduous riparian species such as mountain alder, willow, and black cottonwood.

The stream was perennial and had large amounts of LWD, high amounts of shading, low width to depth ratios and deep, complex pools in levels consistent with desired condition. Sedimentation was low. The upper reach had riparian shrubs such *as* willow and aspen. Large amounts of LWD were probably not present in portions of the upper reaches *as* the stream flowed through meadows. Aspen were present and probably provided some LWD. Streambank stability was high. Resident redband trout were present.

Current Condition

The lower reach of Buckboard Creek is partially intermittent. The last 1/4 *mile* of stream is perennial but flows are very low. The channel type is *a* C. Habitat surveys were unsuccessful because of the low flow conditions. The National Forest portion of the lower reach is within the watershed canyon and has relatively intact riparian vegetation. Stream shading may be as high as 35% in the canyon to as low 5% where it exits private land. The private portion of the stream was not surveyed but had heavy removal of trees from the riparian area, extensive riparian skidding, very few riparian shrubs and an intermittent flow regime. The upper reach had perennial flow, fair stream bank stability, very few riparian shrubs and very low stream shading. Redband trout were limited to a single, deep pool on National Forest Land.

Land Use Effects, Condition Trends and Evaluation

Generally Buckboard Creek does not meet most of the desired condition attributes. Most of the riparian damage has occurred from past heavy grazing, riparian logging, and poorly located roads. The upper reach was logged within the last 3 years under the Jade/Watt timber sale. Willows and aspen are not regenerating throughout the stream's length. Several problem roads should be obliterated **and** revegetated to reduce the amounts of sediment entering the channels and to stop their encroachment on springs.

Recovery of the lower reaches of Buckboard Creek will not occur unless the riparian areas are managed to restore stream bank stability, shading, and width (close monitoring of grazing utilization), and roads causing habitat sedimentation are obliterated and revegetated. If implemented, these measures will improve aquatic habitat quality for the aquatic ecosystem including redband trout. If not implemented aquatic habitat conditions will decline **or** remain static and restoration of redband trout to unused habitat in lower Buckboard Creek will not occur.

Pothole Creek

Historic Condition

The conditions in lower Pothole Creek were different than today (see riparian habitat module). Mature and overmature ponderosa pine and white fir were present within the riparian area along with deciduous riparian species such as mountain alder and willow. The stream was perennial and had large amounts of LWD, high amounts of shading, low width to depths and deep, and complex pools in levels consistent with desired condition. Sedimentation was low and streambank stability was high. The upper reach had riparian shrubs such as willow and aspen. Large amounts of LWD were probably not present in portions of the upper reaches as the stream flowed through meadows. Aspen were present and probably provided some LWD. Resident redband trout were present.

Current Condition

The lower reach of Pothole Creek contains B and C channel types with a width to depth ratios up to 15, average stream shading of approximately 60%, pool habitat frequency of 47% of surface area and a residual depth of .8 feet deep, stream bank stability is 60% stable, and an average of 24 pieces of LWD per mile are present. Sediment is present in levels greater than 35%. Resident redband trout are the only fish species present.

The upper reach of Pothole Creek contains B channel types with a width to depth ratios up to 20, average stream shading of approximately 30%, pool habitat frequency of 44% of surface area and residual pool depth of .5 feet, stream bank stability is 60% stable, and an average of 15 pieces of LWD per mile are present. Sediment is present in levels greater than 35%. Resident redband trout are the only fish species present.

Land Use Effects, Condition Trends and Evaluation

The lower reach of Pothole Creek has experienced localized downcutting and streambank instability. Generally, the lower reach has better habitat than the upper reach. The bank instability, however, causes sedimentation of downstream habitat. Flow is greater, pools are deeper and more frequent, shading is greater and LWD is more frequent and larger in size. In addition, grazing impacts are less in the lower reach than in the upper. Amount of flow and pool habitat is limiting the redband population during the summer.

If grazing impacts are reduced on riparian vegetation in the headwaters of Pothole Creek and instream restoration projects undertaken to create deep, complex pools and increase levels of LWD, habitat quality will improve for native salmonid fish species. In addition, riparian recovery may help to increase the late summer flow in the creek. It is possible logging and roading on private land is at least partially to blame for sedimentation. Improving the riparian condition will help to protect stream banks against high spring time flows and will help to catch overland movement of sediment.

If grazing impacts on the upper reach are not reduced, stream habitat conditions will not improve. This will keep the population of redband trout at current low levels or cause decline. Fish habitat will remain the same or decline over time.

Whitworth Creek (Weyerhaeuser)

Historic Condition

The historic conditions in Whitworth Creek were different than today (see riparian habitat module). Mature and overmature pine and fir were present within the riparian area along with deciduous riparian species such as mountain alder and willow. The shading effect created by the large conifers and deciduous species was likely to have shaded the stream surface up to 80%. It is possible alder were fewer in number along the stream banks than currently (in logged sections). Large amounts of LWD, high amounts of shading, low width to depth ratios, and complex pools were present. Meadow reaches were likely to have low amounts to LWD. Resident redband trout, lampreys, marbled sculpin, and speckled dace were present. In addition, fluvial suckers are thought to have spawned in the lower reach.

Current Condition

Whitworth Creek is a tributary to the watershed and enters just upstream from Blaisdell. The whole length of Whitworth Creek is private and has C and B channel types with low to moderate width to depth. Pool frequency, sedimentation of spawning substrate and pool depth, reduced undercut banks, and reduced shading were identified as the greatest concerns in Whitworth Creek (Weyerhaeuser, unpublished draft 1995). Resident redband trout are present throughout the streams length.

Brown trout, marbled sculpin, and lampreys may also be present but their distribution is unknown. In addition, past stocking introduced coastal rainbow trout to Whitworth Creek. Behnke 1992, reported that Whitworth Creek redband showed some level of hybridization with rainbow trout but that they were mostly of a native genotype.

Land Use Effects, Condition Trends and Evaluation

Sedimentation from roads and road crossings are likely the source of most of the sediment. Some skidding from past logging adjacent to the riparian area may have contributed to existing sedimentation levels. Weyerhaeuser Company has initiated a road closure/improvement program for Whitworth Creek. Further cooperative road obliterations and habitat restoration actions between Weyerhaeuser and the Fremont NF are possible and desirable.

Ish Tish Creek

Historic Condition

The conditions in lower Ish Tish Creek (private) were different than today *(see* riparian habitat module). Mature and overmature ponderosa pine and white fir were present within the riparian area along with deciduous riparian species such as mountain alder and willow. The stream was perennial and had large amounts of LWD, high amounts of shading, low width to depth ratios, and deep, complex pools in levels consistent with desired condition. Several long, meadow reaches had E channel types. sedimentation of aquatic habitat was low. The upper reach' (Fremont NF Land) had mostly ponderosa pine and riparian shrubs such *as* willow. Suckers were seen in the lower reach of Ish Tish Creek historically (Fortune pers. comm. 1992). Streambank stability was high. Resident redband trout and suckers were present.

Current Condition

No surveys of private land were conducted. The lower reach of Ish Tish Creek contains F channel types with unknown habitat conditions. Areas visible from Hwy 140 have high width to depth ratios, high sedimentation, low streambank stability, and intermittent flows. The upper reach of Ish Tish Creek contains B channel types. Low flows precluded habitat surveys. The upper reach of Ish Tish and one of its tributaries were burned in a severe, high intensity fire in 1992. Spring runoff the following year liberated large amounts of sediment which were transported down the channel and deposited on private lands. Large fans of fine sediment were visible from the highway. Fish sampling on National Forest land did not reveal any fish present.

Land Use Effects, Condition Trends and Evaluation

The upper reach of Ish Tish Creek has experienced severe sedimentation from the Robinson Spring fire. Hay bale structures placed in the channel were largely successful at trapping a percentage of the liberated fine sediment. The largest limiting factor on stream conditions is the midsummer low flows. Examination of soil compaction problems caused by the Boys Ranch Timber Salvage Sale and problem roads would benefit aquatic resources. Habitat conditions have been modified to the point that it is unlikely perennial flows will return to lower Ish Tish Creek.

Paradise Creek

Historic Condition

The conditions in Paradise Creek were different than today (see riparian habitat module). Mature and overmature ponderosa pine and white fir were present within the riparian area along with deciduous riparian species such *as* mountain alder and willow. The stream was perennial and had large amounts of LWD, high amounts of shading, low width to depths and deep, complex pools in levels consistent with desired condition. Sedimentation was low. The lowest portion of the stream was likely willow dominated with scattered ponderosa pine. Streambank stability was high. Resident redband trout were present.

Current Condition

Upper Paradise Creek contains B channel types. Lower Paradise Creek is private and therefore was not surveyed. Generally, the portions of lower Paradise Creek visible from Hwy 140 are F channel types. The Fremont NF portion of Paradise Creek has a width to depth ratio of 14, average stream shading of approximately 35%, pool habitat frequency of 5% of surface area and residual pool depth of .7 feet, stream bank stability is greater than 80% stable, and a total of 3 pieces of LWD are present. Sediment *is* not present in levels greater than 35%. Shocking surveys were unable to find any fish present.

Land Use Effects, Condition Trends and Evaluation

The headwaters of Paradise Creek burned in the Robinson Spring Fire. Sedimentation from the fire did not show up in the stream surveys. It is suspected that since only part of the Paradise Creek riparian area burned in the fire, sedimentation was lower than in other drainages. LWD and pools are low in number. The fact that the stream does not support fish indicates that some limiting factor is totally limiting on the population. The small size of the stream, low flows, and poor numbers of pools indicate the stream could have both summer limiting factors (habitat and temperature) as well as winter freezing. Grazing impacts were reported in the upper part and lower part of the reach. The survey noted that in the areas of high livestock utilization, sedimentation was high, and stream banks were visibly damaged. This stream receives late season grazing (Horsefly Allotment).

If grazing impacts are reduced on riparian vegetation in the headwaters of Paradise Creek and instream restoration projects undertaken to create deep, complex pools and increase levels of LWD, habitat quality will improve for native salmonid fish species. In addition, riparian recovery may help to increase the summer flow in the creek.

If grazing *impacts* on the upper reach are not reduced, stream habitat conditions will not improve. This will likely not allow a population of fish to establish in the unoccupied habitat. Fish habitat will remain the same or decline over time.

Historic Condition

Same as Paradise Creek.

Current Condition

Level II habitat surveys were not initiated on this stream because of the small size. Bottom line surveys were completed noting stream bank stability, LWD and shading. Bottom Line surveys indicate approximately 35% stream shading, a total of 9 pieces of LWD and greater than 80% stream bank stability. The Badger Creek contains B channel types.

Land Use Effects, Condition Trends and Evaluation

This stream *is* very small and is unlikely to contain fish. Its potential for a fishery is low. It does have potential for delivery of sediment to reaches of Paradise Creek. Generally its banks appear to be stable, the shading is low, and LWD levels are low. It is likely the same situation exists with Badger *as* Paradise Creek. Shallow pools and low flows are likely limiting the habitat for fish.

Intermittent tributaries to the watershed were not surveyed for fish related habitat during the watershed assessment. Recent surveys however, revealed significant usage of intermittent stream channels by spawning redband trout. This usage is limited to springtime when flows are high. This *is* likely a dispersal mechanism used by redband to fully utilize available habitat and reduce competition. Sampling was conducted on tributaries to Brownsworth Creek which has a large redband population. Redband distribution usually extended up stream to culverts but rarely above. These barriers are common and likely well distributed throughout the basin on intermittent streams. Usage of other tributaries by redband elsewhere in the watershed is unknown but likely common.

Watershed Summary

Aquatic/fish habitat abundance and conditions, and aquatic system processes and flows have been altered by land management activities including road building, timber and range management. High quality salmonid habitat is scarce and is limited to several tributaries and segments of the watershed. Connectivity between bull trout populations has been lost, which, if not corrected, threatens the viability of the species. Flows are likely to have changed with respect to peak, duration and timing. Habitat conditions have changed with respect to temperature, habitat complexity, and sedimentation. These changes have negatively affected populations of native fish species throughout the watershed.

Management activities have affected the aquatic/fish biodiversity , community, composition, distribution and, populations; especially fragmentation of fish species populations, which threaten species viability. Management activities such as timber, livestock grazing, and road building have caused changes in TES species distribution and populations. These activities have caused changes in stream channel conditions which have affected TES species. Habitat conditions have changed so as to no longer provide habitat for some fish species.

Issue *5: Past management activities in combination with natural
(Vegetation) disturbances have altered the function, pattern, composition, structure, and amount of vegetation and the abundance, distribution and condition of wildlife habitat and populations within the South Fork Sprague River Watershed.

Key questions and Parameters

1. How have landscape patterns, composition, and structure changed over time?

   Parameters: past and present landscape metrics (pattern analysis), size, structure, TES species, noxious weeds, roads, and composition of the vegetation.

2. What is the management history, condition, and distribution of the seral stages of forested stands within the watershed?

   Parameters: past and present distribution of condition class and seral stages.

3. What is the overall "Forest Health" of the watershed as measured by the resilience and resistance of the system to catastrophic change?

   Parameters: historic vs. current mortality, disease, fire occurrence.

Stratification

For analysis of forest vegetation, the watershed was stratified into two basic types: Coniferous forest (subshed A, B, C and the eastern half of subshed Z) and sage shrub land (western half of subshed Z).

The forested portion is dominated by mixed conifer stands (white fir with ponderosa and/or lodgepole pine). Stands dominated by white fir are scattered throughout, with concentrations at higher elevations along Coleman Rim (eastside of subshed C) and Gearhart Mountain Wilderness (northern subshed B). Lodgepole pine dominated stands are also present at higher elevations; northern subshed B. Ponderosa pine stands occupy the lower, dryer elevations in the southeast part of subshed Z. See Forest Species Groups map in the Appendix. Mixed conifer and the ponderosa pine stands are where the recent harvesting has taken place. Mixed conifer stands generally have canopy closure between 11-40%; single species dominated stands have higher canopy closure ranging from 40-70%.

Forest areas were further stratified by size/structure; which has been heavily influenced by recent harvesting. Seedlings, saplings, and poles are found on the cut over lands mostly in the center portion of the watershed on both private and Fremont NF lands. Poles and small saw timber occupy the northern and eastern parts. Very little medium saw timber and no large saw timber is present.

Because of the issues identified, the analysis for the SF Sprague watershed is focused on the coniferous forest portions of the watershed.

Historic Condition

Forest Vegetation

Climax plant communities which are species that dominate and continue in all size structure classes of the late successional groups were relatively scarce before the advent of fire control on public lands. The areas were held in a fire climax by recurring low intensity ground fires. Areas frequently visited by fire were dominated by seral species which are the early species group to invade and dominate a site after a stand replacing event. Riparian *areas,* moist sites, high elevation sites, head walls, sites adjacent to rock outcrops, and north slopes were routinely missed by fire. These areas (referred to as refugia) normally burned only under extreme fire weather circumstances. Refugia included areas embedded in seral-dominated areas and large areas that burned infrequently. They have high-severity fire regimes and can be located by identifying the oldest patches of late successional or by dating old stumps. This pattern is similar to other eco-regions on the Fremont NF.

The SF Sprague watershed was dominated by late seral stage to very late seral stage stands of fire climax species on the forested part of the watershed. Some mid-seral stage stands also existed in the southern part of the watershed prior to 1947. The watershed was typical of a landscape that had large areas of later seral stage stands that were infrequently replaced with intense fires. See Tables #1 and #2.

Late successional species were also an overstory component of many frequently underburned, ponderosa pine-dominated areas and colonized new areas as parent overstory trees cast their seed. Historical underburning destroyed most young, fire-intolerant, species. With suppression of natural underburns, large areas were rapidly colonized.

Ponderosa pine climax forests were distributed throughout the watershed. The ponderosa pine series occupied the lowest elevations and the hottest, driest environments where ponderosa pine grows. At higher elevations the ponderosa pine intermixed with white fir, and at lower elevations it merged with the sagebrush desert, desert grasslands, and western juniper. The poorer sites for ponderosa pine were at the lower end of this series in tension with other desert species.

Insects and Disease

The western pine beetle is well known in historical journals and photographs and would have been one of the most obvious insects associated with regularly burned, presettlement forests. Because of the dominance of large, old ponderosa pine and poor growing conditions, particularly when stressed by drought and coupled with similar sized late successional species which could magnify beetle populations, extensive tree killing could occur. In the past years beetles killed trees that were struck by lightning, infected with root diseases, or were old growth trees that were at risk of attack due to low vigor.

Many of the historical outbreaks were obviously severe. The extent and duration we observe today is likely similar to historic patterns. Beetle outbreaks often killed 250 lodgepole pine per acre where stands contained 30-80 (9" DBH) TPA.

Subsequent fire destroyed remaining stands, allowing regeneration; however, fires occurred somewhat randomly, ensuring that any given time, only a small proportion of lodgepole pine stands would be of susceptible size and age. What *is* unique, in central Oregon, is that the environment is so constraining that each new stand will always be lodgepole pine (Hessberg, et al 1994).

Historically, pine engravers attacked young densely stocked ponderosa pine stands. Outbreaks were probably small because IPS beetles preferred trees in dense stands and frequent underburning tended to keep stands well-thinned and free from competition.

Spruce (the Modoc or green phase) budworm outbreaks occurred periodically in mixed coniferous stands. Outbreaks were likely of short duration and small in extent. The food base needed to generate large, prolonged outbreaks was not present. Host species stands were not continuous, limiting available habitat and reducing dispersal potential.

P and S-group annosum root disease centers were relatively uncommon. Without tree harvesting, the disease existed *as a* butt rot of trees with stem wounds. Stands with multiple entries have been shown to have the highest frequency of mortality. Dwarf mistletoes would have occurred in each coniferous *species,* but, none were particularly threatening to their hosts. Mistletoe was seldom eliminated from pine stands by fire, but frequent underburning sanitized ponderosa pine stands by torching the most infected trees. In lodgepole pine, the amount of mistletoe was highly correlated with boom-and-bust fire cycles. Over long periods without fire, mistletoe severity would often be high, depending on the pattern of the last fire event. Re-invasion was rapid when mistletoe-infected islands remained scattered throughout the burned area. A simplified canopy structure and reduced stem density reduced the probability of seed dispersal to susceptible understory.

The roles of insects and diseases *as* disturbance agents in the forest are very closely tied to vegetation patterns. Factors such as species composition, size structure, and density of forest stands are all very important in determining which agents are likely to be operating in the forested environment, their abundance, and how profound their effect is likely to be on that vegetation. By their actions, insects and diseases sometimes alter the very vegetative patterns that provided them with suitable habitat, and set the stage for new processes to occur.

Tree growth and vigor, as influenced by site characteristics and stocking, play a major role in determining where and when insects and disease organisms will be operating. Stand vigor is the principle property of a forest that makes trees resistant to insect and disease attack. Silvicultural treatments that maintain the composition and density of the forested stands are an important part of the function of a healthy ecosystem. Thinning young stands and controlling their species composition are aimed at producing vigorous stands of trees to resist large scale disturbances from these forces. However, cultural treatments of forested stands to increase resistance and resilience to attack may conflict with other resource needs such as hiding or thermal cover. Not all areas will be treated to maintain the greatest health and vigor of the stands. An average growth rate of fifteen twentieths of an inch radial growth per decade has shown to be an adequate growth standard for pine and pine associated stands. A ratio of 80% of the recommended stocking would be a useful goal to maintain stands with a high likelihood of resistance to insect attack. See Table #3 for risk ratings.

Fire

Wildfire occurred with varying frequency, *as* infrequently *as* every 15 years. The historic fuel loading, slope, and aspect would allow low intensity fires to range from ten to one hundred acres for each start. Fuel loading on most sites was kept low by these frequent ground fires. Every five to ten years conditions would allow fires to consume thousands of acres (See Table #4).

Most of the acreage was burned with low intensity fire with pockets of high intensity fires scattered throughout the burn. These high intensity pockets burned dependent on a combination of weather, fuel, and topography. Thousands of acres of high intensity fire were unlikely due to the mosaic pattern of past burning. However, the vegetative community shows that stand replacing fires covered large areas in the watershed at an infrequent interval of between 200 to 500 years.

Much of the area was dominated by large trees with most stands being the open park-like sites pictured in old photographs of the southern pine zone of Eastern Oregon. Frequent low intensity ground fires maintained these open pine stands by eliminating the shade tolerant species such as white fir and reducing the fuel build-up. Most low intensity fire starts were of natural origin. High' intensity large fires were most likely man-caused.

Current Condition

Forest Vegetation

Since the advent of fire protection, there has been a steady shift away from the park-like ponderosa pine stands towards the denser mid to late successional stands. Lacking the low thinning effect of frequent underburning, many stands have been colonized by white fir. The harvesting of the high valued ponderosa pine overstory accelerated the conversion to insect and pathogen susceptible mid-successional forests dominated by white fir. Only a portion of the original seral overstory remains. Other components of the fire climax ecosystem have been reduced or have disappeared along with the stands of large ponderosa pine. The relationship between rising insect and pathogen populations and the shift toward overstocked mid to late successional species is consistent throughout the eastern side of Oregon. Much of the private industrial holdings in the watershed have been harvested and are in an early or mid-seral state of pine and mixed conifer.

Much of the watershed, especially the industrial private lands, have been regenerated to ponderosa pine plantations and are in the early to mid-seral stage. Harvest has occurred on Fremont NF lands also, but not to the extent as on private holdings.

Insects and Disease

Insect activity in the watershed since 1987 has included some tree mortality due to the fir engraver (Scolytus ventralis), western pine beetle (Dendroctonus brevicomis), and mountain pine beetle (D. ponderosae). Insects such as the pine engraver (Ips pini), Douglas-fir tussock moth (Orgyia pseudotsugata) and Modoc budworm (Choristoneura viridis) have been insignificant during that time period even though habitat exists for them in the watershed.

The combinations of site characteristics, growing conditions, and vegetative patterns often allow us to predict changes that are likely to occur due to the actions of insects and diseases. By the same token, a recent history of insect and disease infestations would also imply that certain vegetative patterns were present on the landscape when these disturbance agents were at work. For example, the extremely high levels of fir engraver activity across the Fremont NF during the early 1990's reflected high stocking levels of white fir in fire-climax ponderosa pine sites. Similarly, high incidence of annosus root disease in many ponderosa pine stands suggests low-productivity sites combined with a cutting history that has produced many large stumps to be inoculated by the fungus.

Perhaps the most dramatic insect activity in recent years has involved the fir engraver. Small patches of white fir mortality were evident in 1989 in a narrow band through the middle of the watershed (Palisade Rocks to Yaden Flat). Mortality due to fir engraver was lighter in 1990, but was quite conspicuous again in 1991 between Bare Flat and Mitchell Monument. Fir engraver levels were low in 1992, but surged again in 1993 and 1994 when white fir mortality was noted in the southeast and northwest corners of the watershed. In some cases, the same areas have been affected for consecutive years, indicating that the cumulative effects on stands containing white fir may be quite extensive.

During the same time period, there has been scattered activity by the western pine beetle throughout the watershed. Mortality was fairly low in 1989, with some trees, mostly large ponderosa pine, killed northwest of Quartz Mountain and northward. In 1990, mortality was most evident south of Yaden Flat and in scattered patches south of the Gearhart Mountain Wilderness. Western pine beetle was less evident in 1991 and 1992.

Tree mortality increased significantly in 1993 and 1994 when numerous large pines were killed around Cottonwood Spring and southward to Whitworth Creek and Jack Flat on the east side, and near Boyd Spring on the west side of the watershed. These bark beetles are active in both the ponderosa pine series and white fir (pine associated) series.

Recent mountain pine beetle activity has been noted in second growth stands of ponderosa pine throughout the watershed. Since 1989, small pockets of dead trees have been evident in the Dutchman Flat/Boyd Spring area, Round Butte to Grouse Prairie, Cottonwood Spring, and Owen Butte.

Within the ponderosa pine series, there are some areas of low-productivity and high risk for annosus root disease. These are concentrated in the southeast corner of the watershed between Quartz Mountain and Mitchell Monument. Within these high risk areas, infection levels can be highly correlated with the number of past harvest entries.

Where more than two entries have occurred, there is a high likelihood that all large pine stumps have been infected. The incidence of annosus root disease within the white fir component is estimated in the following manner: for unentered white fir stands - the infection level is 12%; for white fir stands where one harvest entry has occurred - the infection level is 40%; in stands of white fir entered more than once - the infection level is 100%.

Fire

Wildfires in the watershed are increasing in size and intensity. This can be attributed to two factors: 1) increased fuel loading from both natural fuel accumulation and activity created fuels and 2) the shift from early to mid-seral stand structure (which brings a dramatic increase in fire intolerant white fir in the understory). The combination of more fuel and more fuel ladders has increased the likelihood of stand replacing events. Mortality in the mid-seral component has also increased the thousand-hour time lag fuel component, further increasing fire intensity.

The current fire frequency is 0.084 fires per year per thousand acres. This probability would indicate a return interval of twelve years with an average size of low intensity fires of 0.25 acres. The smaller size fires result from increased wildfire suppression over the last eighty years. High intensity fires have burned an average of 1,100 acres every thirteen years over the last fifty years. Most of the stand replacing events have been occurred in the last fifteen years. The majority of fire starts in the watershed are of natural origin. Natural fuel underburning to reduce fuel loads is being done; low intensity fire has been used on about 600 acres to date.

Desired Condition

Forest Vegetation

Vegetation within the watershed includes a diversity of composition, structure, and pattern. This includes species/stand, genetic, and landscape level function. Diversity stresses the spatial relationships affecting forest structure, composition, and function. Landscape patterns *as measured* by the metrics of abundance, density, richness, evenness, and variety of life forms are close to the Historical Range of Variability; see Tables #1 and #2.

Vegetation composition exhibits a high level of genetic diversity, maintaining the watershed's resistance to and resilience from catastrophic loss due to unexpected events (i.e. wildfire and insect or disease attacks). Management practices are designed to retain genetic diversity among all site-adapted species across all forested areas.

A wide distribution of plant communities, including a variety of communities with different successional stages and age classes, is essential to maintaining a resilient landscape that is resistant to the landscape. To obtain the picture of the seral stage, distribution of the watershed, the harvest update was performed on the condition class layer in GIS. From this update and stand exam data, the present picture of seral stage distribution was formed. Total acres vaires due to differences is queries made, management should reflect the percentage allocations for each seral stage.

Table 1
Seral Stage Composition

Seral Stage	Historic Condition Acres	Historic Condition Percent	[redacted]	[redacted]	Desired Condition Acres	Desired Condition Percent
Early	5,251	6.41	[redacted]	[redacted]	5,000	6.17
Mid	11,041	13.49	[redacted]	[redacted]	10,000	12.35
Late	13,248	16.18	[redacted]	[redacted]	30,000	37.04
Very Late	27,620	33.74	[redacted]	[redacted]	11,000	13.58
Unclassified	24,698*	30.18	[redacted]	[redacted]	25,000	30.86
TOTAL	81,858	100.00	79,111	100.00	81,000	100.00

* Unclassified portion of the watershed is mostly non-forested areas in the western part of the watershed.

Harvest in the very late seral stage stands has reduced the amount of this stage to levels much below the historic condition. Much of the watershed is in an early to mid seral stage especially the private land that has been extensively harvested.

Table 2
Vegetation Type

Vegetation Pattern	Historic Condition Acres	Historic Condition Percent	Current Condition Acres	Current Condition Percent	Desired Condition Acres	Desired Condition Percent
Ponderosa Pine	32,000	58	29,500	36	47,600	58
Pine Associated	13,297	24	26,300	32	20,500	25
Lodgepole	3,163	6	3,300	4	4,100	5
Unclassified*	6,359	12	3,000	28	9,900	12
TOTAL	54,818	100	82,100	100	82,100	100

* Unclassified acres were of unknown or non-timbered vegetation types

Insect and Disease

Insect and disease occurrence was obtained using ponderosa pine, mixed conifer, and Lodgepole pine communities. The ratings are subjective based on current literature and estimates from Area 4 entomologists and pathologist.

Table 3
Insect and Disease Rating

Damage Agent	Historical Condition	Current Condition	Desired Condition
Bark Beetles			
Mountain Pine Beetle	L	M	L
Western Pine Beetle	M	H	L
Pine Engraver	L	M	L
Fir Engraver	L	H	L
Modoc bud-worm	L	H	M
Annosus Root Disease	L	H	L
Dwarf Mistletoe	M	M	M

The key to keeping these insect and disease disturbance agents operating at natural or acceptable levels involves managing the vegetation patterns across the landscape. The degree to which a forest is healthy can be measured by the overabundance or absence of the various combinations of size, structure, and species composition that can occur within a particular vegetation series or eco-class. The desired vegetative condition, then, from a **forest** health perspective,would be one where all possible combinations of size, structure, and species composition are represented in a balanced distribution across the landscape. This type of vegetative assemblage conveys a resilience to the forest and limits the scale at which disturbance agents operate. Furthermore, it provides "replacements" for those components which are temporarily lost due to perturbations in the system. This balance of sizes, structures, and species composition needs to be attained in each of the vegetative series of the eco-classes.

Fire

The picture of fire history was obtained using fire return interval in the pine, pine associated, lodgepole pine, and other productivity classes. Fire occurrence was stratified by subshed within the watershed.

Table 4
Fire Regime

Factor	Historical Condition	Current Condition	Desired Condition
Fire Return Interval (Years)			
Fire Occurrence (Starts/1,000 ac/yr)	.071	.084	.07-.08
Low intensity ground fires	15	12	
Large stand replacing fires	200-500	13	12-15
			200-300
Average Fire Size (Acres)			
Low intensity ground fires	10-100	.25	8,000-1,2000
Large stand replacing fires*	2000+	1,100	-0-
Natural Fuels Underburning (Acres) (Low intensity controlled fire)	600 total/decade for all conditions		

Land *Use* Effects, Condition Trends and Evaluation

The ecological classification of the area is unlikely to change over time because it is based on site potential to produce plant associations and communities throughout time. Important features such as connectivity, edge, travel corridors for wildlife, patch size, and juxtaposition will be incorporated into project planning and evaluation.

Natural progression of these stands will move them into the later successional stages, but the resulting stand may not represent the most desirable *species* mix for the whole watershed. Restoration of ponderosa pine on sites where it is well adapted will depend on the management of the existing stand structure on public land. The major influence that will cause this change will be the use of prescribed fire to reduce the encroaching white fir understory on pine sites. Other sites will progress to a climax white fir condition unless management of the understory and species mix is undertaken.

Harvest of the large old growth component on public land has stopped in the recent past. The remaining old tree component will continue for a short period of time but is reaching the end of the normal life span of ponderosa pine. Most old trees that are over 300 years old will die within the next five decades., Some of the stands in the late or very late seral stage will replace the older component of stand structure.

However, it will be several hundred years before the historic stand structure in the watershed will be achieved under natural or no management conditions. The late and very late seral staged stand in the northern part of the watershed are in the Gearhart Mountain Wilderness. These stands will continue their normal progression toward climax species of true firs. Large fires may cause stand replacement but most fire occurrence will be small starts and result in a mosaic of size structure.

Many of the stands on public land are overstocked with white fir and younger pine species. Private lands are also overstocked at the present time. These stands will continue to be susceptible to insect attack in increasing numbers as the stands progress in age and the effects of drought coupled with overstocking continue in the natural cycle. Root disease will continue to increase. Most stands have been entered at least once, and each additional entry increases the spread of the root disease. Most stands will approach 100% infection without preventative measures with in the next rotation of tree growth.

Much of the private land has been treated for fuel reduction in the process of harvest and plantation establishment. The public land has had less fuel treatment and has shifted toward a white fir understory. Elimination of naturally occurring low intensity wildfire and the species shift make the watershed less resilient to a catastrophic event than the historical condition. The drought cycle and accumulation of natural fuel will cause a decline in the late seral species. The cumulative impact on the forested resource will be a continual decline in the amount of late to very late seral staged stands as the older pine and fir over story are out competed by the overstocked fir understory.

Issue #5: Wildlife Resource Section - Past management activities in (Wildlife) combination with natural disturbances have altered the function, pattern, composition, structure, and amount of vegetation and the abundance, distribution and condition of wildlife habitat and populations within the South Fork Sprague River Watershed.

Key Questions and Parameters

1. What are the significant differences and trends between historic and current TES and MI wildlife species populations, habitat abundance, distributions, diversity, and conditions?

   Parameters: structure, species locations, landscape patterns, and composition of the vegetation.

   Stratification

To narrow the scope of the analysis of wildlife resources, the strategy was to first stratify the assessment process into two tiers: 1) a "fine filter" of the abundance, distribution and habitat conditions of selected, individual TES, MI and keystone species associated with dead wood and late seral forest habitat or other unique habitats and 2) a "coarse filter" of all other wildlife species general status and habitat conditions using general landscape community composition, structure, and pattern as a surrogate for more specific information on the abundance, distribution and habitat conditions of several hundred other individual wildlife species. The coarse filter approach assumes that if similar landscape patterns and processes are maintained to those that governed species evolution and survival, a full complement of species will persist, and biodiversity will be conserved. Application of this concept requires understanding the natural variability of landscape patterns and processes. Because of the nature of the assessment information that was available on wildlife species and their habitats, the analysis for all wildlife species (including TES, MI, and keystone species) followed more of the coarse filter approach than was originally intended.
To help more clearly define the distribution and/or density, and habitat conditions for wildlife species, the watershed was stratified by subshed. An analysis by subshed helped to establish a spatial range of variability for resource conditions, since information on a temporal range of variability was not available. Also, for big game species (deer and elk), ranges were stratified by herd and management unit and seasonal *use* to help simplify analysis. In addition, for some wildlife species, known or suspected territories or home ranges were stratified into subareas representing specific life processes such as breeding, nesting, roosting, rearing and foraging areas.

LATE SERAL FOREST AND DEAD WOOD HABITAT (WATERSHED)

Historic Condition

The abundance, distribution, connectivity, and quality of suitable habitat for MI and other species associated with dead wood and late seral forest habitats was significantly greater than that which is currently present. The landscape was dominated primarily by a contiguous late seral pine and pine associated forest with a small area of late seral lodgepole pine. Average, maximum, and range of patch sizes were large and most of the patches were high quality interior habitat. Large diameter live trees, snags, and down wood were common and distributed throughout the landscape.

Gaps and fragmentation were minimal and mostly a result of the occurrence of natural meadows or burns. It is highly probable that because of more abundant and suitable habitat conditions for MI and other species, they were more numerous and widely distributed, especially ponderosa pine associated species, than they are today.

Current Condition

The abundance, distribution, connectivity, and quality of suitable habitat for MI and other species associated with dead wood and late seral forest habitats, especially ponderosa pine, has been significantly reduced from historic times. Large diameter live trees, snags, and down wood are conspicuously absent from large areas of the landscape, and greatly reduced in abundance and distribution on other areas. Overstocked understories in some stands are causing overstory mortality of large trees and unraveling the late seral forest character. The landscape is now dominated by disturbance patches of early and mid seral forest habitats created primarily from even-aged regeneration timber harvest. Average. and maximum patch sizes of late seral forest have been reduced significantly, and most of the patches are now less suitable ecotone rather than interior habitat. Disturbance patches have created gaps and significantly fragmented the habitat. Many isolated patches are now sink habitats for MI and other late seral associated species. Populations are lower than historical levels and isolation and crowding threaten their stability. The present condition of late seral forest habitat favors those species whose preferred habitat is pine associated, and negatively affects those associated with ponderosa pine.

Land Use Effects, Condition Trends and Evaluation

Available and suitable dead wood and late seral forest habitat has decreased primarily *as a* result of timber harvest activities, and secondarily as a result of wildfire, insect and disease infestations, firewood cutting, hazard tree removal, and in some instances in ponderosa pine, as a result of fire suppression. These disturbance agents have removed large diameter live trees, snags, and down wood, reduced patch sizes and connectivity, diminished the amount of high quality late seral interior habitat and overstory canopy cover, and increased gaps and fragmentation, and consequently, the amount of lower quality late seral ecotone habitat.

Ponderosa pine habitat has experienced the greatest reduction in dead wood and late seral forest. Past management practices of selective harvesting and fire suppression have encouraged forest stands previously dominated by pine to become stands dominated by more shade tolerant white fir. Also, large areas of pine were removed by regeneration timber harvest.

The shifting plant species composition on warm fir sites toward a mixed conifer composition could eventually provide additional habitat for pileated, marten, and other associated species as these forest stands progress toward the late seral condition. Overstocked stands on some sites have reduced the suitability of late seral habitat for some species such as goshawk and Lewis' and white-headed woodpecker which prefer more open understories.

The loss of available dead wood and late seral forest habitat and the consequent decline in habitat suitability and distribution has led to isolation of individuals and single pairs in fragmented late seral patches, and large areas of early/mid seral forest habitat within the watershed that will no longer meet the habitat needs of the associated species.

Overall abundance and distribution of these species has most likely declined from historic levels, especially species associated with open park like stands of pine such as Lewis' and white-headed woodpecker. Isolation and crowding of individuals and pairs threatens the stability of some species.

Under the assumed forest management scenario on private lands, late seral forest and dead wood habitat will never again be a part of the landscape. The forest habitat that matures on private lands in the future probably will always be sink habitat for MI and other species associated with late seral forest and deadwood habitats.

On Fremont NF lands, late seral forest and dead wood habitat should gradually increase in abundance, contiguity, distribution, and quality over the long term as management shifts to longer rotation uneven-aged treatments and tree plantations grow into mature forests. Edge contrast between existing late seral forest and early/mid seral forest will slowly diminish as tree plantations mature over time and Fremont NF plantations are managed for structural diversity. Road closures and obliterations will help reduce habitat fragmentation. Sanitation/salvage harvest prescriptions and underburning will continue to reduce deadwood habitats, but sufficient snags and down wood should be protected and created through insect and disease and wildfire to maintain stable populations of deadwood associated MI and other species. Prescribed underburns and thinning should help restore more open parklike stands of late seral pine. If the current drought continues and/or understory thinning of forest stands is not a priority management action, then existing stands of late seral forest habitat are threatened with potential insect and disease outbreaks

and catastrophic wildfire. However, low frequency, high intensity stand replacing wildfires seem to be characteristic over most of the landscape now in late seral forest, so the potential threat may be low.

It is unlikely that the watershed will ever again provide late seral forest habitat within the range of historic variability. Forest stands on private commercial lands will most likely not provide future late seral forest habitat conditions that occurred there historically. Large areas of the landscape in private ownership will be absent of MI and other species associated with late seral forest. The intermingled ownership pattern will continue to contribute to the gaps and fragmentation of late seral forest habitat that occur on Fremont NF lands. This condition isolates and crowds some habitats, individuals and pairs, and creates sink populations. The future abundance and distribution of species associated with late seral forest will be less than occurred historically.

To restore late seral forest habitat conditions on Fremont NF lands and to move toward the historic range of variability, forest management actions must be implemented to increase the abundance, distribution, patch size, connectivity, and suitability of late seral forest habitat, including large diameter live trees, snags, and down wood, especially in ponderosa pine forest.

Subshed A

Historic Condition

The landscape was dominated (85%) by suitable habitat for MI and other species associated with deadwood and late seral pine and pine associated forest. The forest was virtually contiguous habitat to facilitate dispersal, colonization, genetic interchange, and the distribution of species throughout the entire subshed.

Some gaps primarily from natural meadows occurred along the eastern, southern and northern boundaries of the landscape, but the extent and effect on habitat quality was limited. Only 5% of the forest habitat on the landscape was unsuitable for MI species. Patch size was large enough to support multiple pairs and multiple species of all the MI species. The largest patch was 49% of the landscape area. The landscape also was dominated (greater than 50%) by high quality core or interior late seral habitat un-influenced by effects of edge. Over 60% of all late seral habitat was core area. The mean size of the core patches was 485 acres. Populations of all MI species were probably stable to increasing and distributed throughout the landscape.

Current Condition

The landscape is now dominated (75%) by disturbance patches from even-age regeneration timber harvest which provides suitable habitat for wildlife species associated with early seral pine and pine associated forest. The area of late seral habitat in the landscape has been reduced 60%, and only 35% of that historically present now exists. Only one area of contiguous pine associated habitat large enough (1,500+ acres) to support multiple pairs and multiple species exists in the northern end of the landscape. The remaining pine associated late seral habitat in the landscape is highly fragmented. Almost all late seral pine habitat has been harvested, and that which remains is highly fragmented. Patch size has been reduced significantly. The largest patch is now only 6% of the landscape area. Only about 3% of the landscape and 10% of late seral habitat is now high quality core pine associated late seral habitat. Greater than 95% of this occurs in the Gearhart Mountain Wilderness.

Late seral pine core habitat no longer occurs in the landscape. The average size of core patches has been reduced to 29 acres, or just 6% of the historical average. Late seral habitat is now dominated (90%) by ecotone effects from the significant increase in edge and fragmentation of late seral habitat as a result of timber harvest. Road density has added to the increase in edge and fragmentation of habitat.

MI species associated with pine probably no longer occur on the landscape. Populations of MI species may be stable around the large block of contiguous pine associated habitat in the Gearhart Mountain Wilderness on the northern end of the landscape. Isolated pairs or individuals in the marginal two-storied and highly fragmented pine associated habitat patches in the southwest corner and center of the landscape are probably unstable. About 70% of the forested landscape no longer meet the habitat needs of MI or other species associated with deadwood and late seral forest.

Subshed B

Historic Condition

The landscape was dominated (90%) by suitable habitat for MI and other species associated with deadwood and late seral pine, pine associated and lodgepole forest. The forest was virtually contiguous habitat to facilitate dispersal, colonization, genetic interchange and the distribution of species throughout the entire subshed.

Some fragmentation primarily from natural meadows and disturbance patches occurred along the southwest end and near the center of the landscape, but its extent and effect on habitat quality was limited. Only 5% of the forest habitat on the landscape was unsuitable for MI species. Patch size was large enough to support multiple pairs and multiple species of all the MI species. The largest patch was 51% of the landscape area. About 40+% of the landscape provided high quality core or interior late seral habitat un-influenced by effects of edge. Over 50% of all late seral habitat was core area. The average size of the core patches was 100 acres. Populations of all MI species were probably stable to increasing and distributed throughout the landscape.

Current Condition

The landscape is still characterized by predominantly (52%) suitable habitat for MI and other species associated with deadwood and late seral pine, pine associated, and lodgepole forest. Most of the remaining landscape (41%) is disturbance patches from even-age regeneration timber harvest which provides suitable habitat for wildlife species associated with early seral pine, pine associated, and lodgepole forest. The area of late seral habitat in the landscape has been reduced 38%; only 60% of that historically present now exists.

Only one area of contiguous pine associated habitat is large enough (3,000+ ac.) to support multiple pairs and multiple species exists in the northern end of the landscape in the Gearhart Mountain Wilderness. The remaining pine associated, late seral habitat in the landscape is primarily two-storied and highly fragmented. Almost all late seral pine habitat has been harvested. That which remains is highly fragmented. Patch size has been reduced significantly. The largest patch is now only 17% of the landscape area. Only about 19% of the landscape and 36% of late seral habitat is now high quality core pine associated habitat. The only large patch of unfragmented core habitat occurs in the Gearhart Mountain Wilderness. One other core patch of noteworthy size (greater than 300 acres) is located in the south-central part of the landscape.

The average size of core patches has been reduced to 70 acres, still almost 90% of the historical average. Late seral habitat is now dominated (64%) by ecotone effects from the significant increase in edge and fragmentation of late seral habitat as a result of timber harvest.

Road density has added to the increase in edge and fragmentation of habitat. Populations of MI species may be stable around the large block of contiguous pine associated habitat in the Gearhart Mountain Wilderness on the northern end of the landscape. Isolated pairs or individuals in the marginal two-storied and highly fragmented pine associated habitat patches in the southwest corner of the landscape are probably unstable. Pairs or individuals occupying the southeast corner of the landscape adjacent to Coleman Rim are probably marginally stable. About 40% of the forested landscape no longer meet the habitat needs of MI or other species associated with deadwood and late seral forest.

Subshed C

Historic Condition

The landscape was dominated (71%) by suitable habitat for MI and other species associated with deadwood and late seral pine, and pine associated forest. All but the southwest corner of the landscape was virtually contiguous late seral habitat to facilitate dispersal, colonization, genetic interchange, and the distribution of species throughout the entire subshed. Fragmentation, primarily from disturbance patches, occurred along the southwest corner and near the center of the landscape and effectively separated the late seral forest into northern and southern halves. The halves were only connected along the eastern edge of the landscape. Only 25% of the forest habitat on the landscape was unsuitable for MI species. Patch sizes were large enough to support multiple pairs and multiple species of all the MI species. The largest patch was 40% of the landscape area.

About 31+% of the landscape provided high quality core or interior late seral habitat un-influenced by effects of edge. Over 45% of all late seral habitat was core area. The average size of the core patches was 90 acres. Populations of all MI species were probably stable to increasing and distributed throughout the landscape. However, some isolation of populations was probable along the western edge of the landscape where disturbance patches separated the late seral forest into disjunct matrix areas.

Current Condition

The landscape is still characterized by predominantly (56%) suitable habitat for MI and other species associated with deadwood and late seral pine and pine associated forest.

Most of the remaining landscape (38%) is disturbance patches from even-age regeneration timber harvest which provides suitable habitat for wildlife species associated with early seral pine and pine associated forest. The area of late seral habitat in the landscape has been reduced only 15% and almost 80% of that historically present still exists. The entire eastern half of the landscape is still a contiguous matrix of pine associated habitat large enough (4,000+ ac.) to support multiple pairs and multiple species. The most contiguous patch of highest quality late seral habitat occurs along the Coleman Rim. The remaining pine associated late seral habitat in the landscape is primarily two-storied, but it is mostly contiguous. Patch size has been reduced significantly. The largest patch is now only 19% of the landscape area.

Only about 18% of the landscape and 33% of late seral habitat is now high quality core pine associated habitat. The only really large core patch of noteworthy **size** (about 1,600 acres) is two-storied and located in the south-central part of the landscape. The average size of core patches has been reduced to 83 acres, still almost 95% of the historical average. Late seral habitat is now dominated (67%) by ecotone effects from the significant increase in edge and fragmentation of late seral habitat as a result of timber harvest. Road density has added to the increase in edge and fragmentation of habitat. Populations of MI species may be stable around the contiguous pine associated habitat along the Coleman Rim area on the eastern edge of the landscape.

Pairs or individuals occupying the two-storied late seral habitat in east-central half of the landscape are probably marginally stable. About 40% of the forested landscape no longer meet the habitat needs of MI or other species associated with deadwood and late seral forest.

Subshed Z

Historic Condition

The landscape was dominated (73%) by suitable habitat for MI species associated with natural non-forest patches, and disturbance patches created from even-aged regeneration timber harvest. The entire western half of the landscape is a contiguous matrix of sagebrush/grass/juniper. Forest habitat was characterized by a proportionate amount of late seral and early/mid seral conditions. About 52% of the forest habitat on the landscape was unsuitable for MI species. Only 27% of the landscape was in late seral forest habitat. Patch size probably was not large enough to support multiple pairs and multiple species of any management indicator species. The largest patch was only 8% of the landscape area.

Only a small proportion (greater than 9%) of the landscape was characterized by high quality core or interior late seral habitat not being influenced by effects of edge. About 43% of all late seral habitat was core area. The mean size of the core patches was 117 acres. Populations of all management indicator species were separated and isolated to the fragmented late seral patches in the south-central and northeast areas of the landscape.

Current Condition

An even greater proportion (96%) of the landscape is now dominated by natural non-forest patches and disturbance patches from even-age regeneration timber harvest and wildfire. The area of late seral habitat in the landscape has been reduced 25% and only 16% of that historically present now exists. The remaining pine and pine associated, late seral habitat in the landscape is highly fragmented. No area is large enough to support multiple pairs or multiple MI species.

Patch size has been reduced significantly. The largest patch is now only 1% of the landscape area. Only about 1% of the landscape and 1% of late seral habitat is now high quality core pine late seral habitat. Late seral pine associated core habitat no longer occurs in the landscape. The average size of core patches has been reduced to 3 acres, or just 3% of the historical average. Late seral habitat is now dominated (99%) by ecotone effects from the significant increase in edge and fragmentation of late seral habitat as a result of timber harvest and wildfire.

Road density has added to the increase in edge and fragmentation of habitat. Isolated pairs or individuals of MI species in the predominately marginal two-storied and highly fragmented pine and pine associated habitat patches that remain on the landscape are probably highly unstable. This sink habitat cannot maintain a population without continuous immigration from nearby source habitat. About 95% of the forested landscape no longer meet the habitat needs of MI species.

Desired Condition (Late Seral Forest Habitat)

The late seral forest network protects and enhances the habitat effectiveness to sustain associated MI wildlife species. Characteristic landscape scale features are restored. Late seral forest habitat representation is emphasized rather than preservation of individual patches.

Size and number of designated old growth units support multiple breeding pairs and multiple species. A patch pattern exists with connective corridors based on current known home range size and dispersal capabilities of the MI species. Patch proximity and distribution allow recolonization, genetic interaction and exchange throughout the population, and maintenance of each species' general distribution. Old growth patches and corridors provide suitable habitat to meet the needs of MI species for reproduction and survival.

A matrix exists of late seral forest habitat within the natural range of historic variability in subsheds A, B, and C. 70% of the late seral forest landscape provides habitat and the area of the largest late seral patch is at least 40% of the total landscape area. Late seral patch size averages 700 acres. At least one patch is greater than 6,000 acres and at least 2 patches greater than 2,000 acres or one greater than 4,000.

An old growth restoration zone (600-1,200 feet) surrounds designated and "other" old growth to buffer and increase forest interior habitat to a level within the natural range of historic variability. In subsheds A, B, and C, 40% of the landscape and 45% of the total late seral forest provides interior "core" habitat. Core area patch size averages 100 acres and at least one core area is greater than 2,400 acres.

Large designated old growth stands exist within 1.5 miles of existing designated and remaining old growth stands, and distributed throughout subsheds A, B, and C. Stands are resistant to natural disturbances over the long term and have the most suitable habitat for the species of interest. Some of the most stable and suitable stands occur around riparian areas, on north and east aspects, and at higher elevations.

Pine and pine associated forests are a three-tiered system maintaining a dynamic balance in late seral forest patch loss and development over time and space.

Connectivity exists between all late seral stands and between all designated old growth stands in subsheds A, B, and C. Desired conditions for connectivity are described in the "Forest Plan Amendment for Interim Standards" under "Interim Wildlife Standards". In addition, corridors or stepping-stones are oriented both east to west and north to south, relatively straight, of constant width, and established along riparian zones, ridges, and between sub-sheds and watersheds.

Forest stands have adequate abundance and distribution of large diameter snags, remnant, large diameter live late seral trees, and large down logs.

No increase in fragmentation of late/old seral stands takes place. Increase the amount and width of late seral forest adjacent to stream courses. Road density is less than 2.5 miles per square mile.

Open park-like stands exist (average canopy density less than 30%) of late seral ponderosa pine with average tree diameters greater than 15" for white-headed woodpecker and pygmy nuthatch.

In all stands of ponderosa pine and pine associated forest, snags and green replacement trees are greater than or equal to 15" dbh at 100% potential population **levels** of primary cavity excavators. For lodgepole pine stands, snags and green replacement trees are greater than or equal to 10" dbh at 100% potential population levels of cavity excavators. Specific desired conditions for snags and down logs are described in the "Forest Plan Amendment for Interim Standards" under "Interim Wildlife Standards". Snag and green replacement tree densities and distributions provide 100% habitat potential for cavity, excavators.

The table below displays the standard for "...snag and green replacement/roost trees of > 15" DBH at 100% potential population levels for primary cavity excavators". This is NOT 100% of population potential as defined in the Forest Plan.

Table 5
Snag Replacement Requirements

Forest Type	DBH	Height	Trees/Ac.
PINE/PINE ASSOCIATED	15" minimum 20" preferred	20'+	3 dead + 2 green
	10" minimum 12" preferred	20'+	1 dead + 3 green
LODGEPOLE PINE	12" min.	15'+	1 dead + 1 green
	10" min.	15'+	1 dead + 1 green

Snags and green replacement trees occur in dispersed clumps rather than individual trees uniformly scattered over the landscape. There is at least one clump for every five acres that contains both dead and green replacement trees. This is based on the smallest home range size of primary excavator species in the current literature. Snags and replacement trees represent the same species composition as existing stands in the area.

Snag and green tree replacement habitat within the watershed supports all primary excavator populations at 60% of potential.

MI/KEYSTONE SPECIES ASSOCIATED WITH UNIQUE HABITATS

Big Game - Edge and Security Habitat

Historic Condition

From relatively few deer at the turn of the century, the Interstate herd peaked during the late 1930's at approximately 30,000 deer. The herd declined slightly during the early 1940's, then increased through 1951.

During the 1950's, periodic winter die-offs and antlerless harvests maintained a stable herd at about 20,000 deer post winter. By the late 1950's the herd began a gradual decline that increased dramatically in the late 1960's after a temporary peak in 1967.

Hard winters continued into the early 1970's and pulled the herd down to new lows, less than 10,000 deer. Herd recovery has been suppressed since then. These population estimates may under-represent true herd size by 30%. The dynamics of the herd during the first half of the century were primarily tied to weather variations, responses to summer range wildfires, browse abundance on winter range, predator reductions from disease, protection from hunting, and a sharp reduction in competition with livestock.

No assessment information was available on historic elk populations in the watershed. Nor was any information available on the seasonal distribution and use of the watershed by elk.

The seasonal distribution of deer probably was similar to that which exists today. Late seral forest cover dominated the landscape and habitat security was high even though many stands had more open understories. More habitat was available and deer had greater security because fewer roads existed than are present today. Open forage areas primarily were limited to natural meadows and sagebrush cover types, although more mixed shrub habitat created by wildfire apparently occurred on transition/summer range than *is* present today. The only large recorded project fire area was the Owen Butte burn on transition range in 1946. Browse on winter range was more abundant and in better condition.

<u>Current Condition</u>

The Interstate deer herd size is about 60% below the early 1950 peak population which is when fairly reliable quantitative counts of herd size were initiated. For the last 20 years, the population has been relatively stable and appears to be at an equilibrium with the carrying capacity of its seasonal ranges. The elk population in the South Central management area within which the watershed *is* located *is* approximately 1,300 animals and steadily increasing.

The Interstate deer and elk herds occupy the watershed year long. Approximately 41, 31, and 28% of the watershed is used by deer and elk as summer, winter, and spring/fall transition respectively. Deer and elk winter range occurs mostly in the western half of the watershed, while summer range occurs along the eastern half. Deer transition range is also present in the north and south ends of the watershed. Major north/east to west spring/fall migration corridors for both deer and elk occur along Brownsworth, Corral, and Pothole Creeks, and the middle/upper reaches of the SF Sprague River.

Much of the winter range on private land has been developed into pasture land, hayfields and commercially managed timber lands. These activities have reduced the availability and abundance of winter forage and cover for big game. Fire suppression has contributed to the decline in the availability, abundance and quality of forage species, particularly *as* shrub production declines with advancing plant succession.

The absence of fire also has resulted in an increase in the density and distribution of juniper which also has reduced the availability and abundance of forage, but has increased the amount of cover on both federal and private land. Historically, too many deer on the winter range have contributed to the degraded condition of forage resources there today. The present livestock and big game use continue to suppress recovery of the forage base.

Ranching activities and travel corridors for public access on federal lands have also increased disturbances and displaced animals from some preferred habitats.

Transition and summer ranges and migration corridors on private and federal lands have been extensively altered by commercial timber harvest, livestock grazing, fire suppression, and roads for public and industrial access. Insect and disease outbreaks in forest stands are presently modifying all seasonal ranges and migration corridors on all ownerships in the watershed.

Deer and elk foraging habitat has increased over time *as a* result of timber harvest activities which created open forage areas in close proximity to forest cover and now dominates the landscape. Conversely, forest stands are much denser than had been recorded at the turn of the century. Dense thickets of young understory pine and fir are a significant departure from the open park-like appearance of historical pine forests. Natural openings in the forest have either decreased or been lost altogether. Mixed conifer and lodgepole pine forests have encroached in meadows. Herbaceous understory and meadow forage species have declined as forest structure has changed. In addition there has been a buildup of fine debris on the forest floor from fire suppression which has resulted in a continuous decline in the productivity of herbaceous understory forage species. However, the increase in foraging habitat as a result of timber harvest probably exceeds the loss of forage resources in overstocked forest stands.

Even though forage habitat is greater than during historic times, the deer population remains suppressed at a level approximately 60% below the peak herd size in the early 1950's. Therefore, more subtle characteristics of the forage resource not apparent at the landscape analysis scale such as forage quality or quantity may be limiting the recovery of the population. The best documented study of factors limiting the deer population indicated that poor spring/summer diet quality resulted in low fawn survival. The study strongly implicated wildfire on summer range as the principal factor affecting forage nutrition and herd dynamics. That being the case, both the Round Butte fire in 1955 and the more recent Robinson Springs fire in 1992 on transition range, would have significantly increased forage production and quality, and hopefully fawn survival on a limited area of watershed for at least a 15 year period. It was expected that the extensive open forage areas created by regeneration timber harvest would mimic the forage production and quality created on burn areas. However, responses of forage species to these two disturbances on the Interstate herd range seem to be widely divergent.

Cover habitat has declined over time primarily as *a* result of even-age regeneration timber harvest activities. Conversely, the amount and distribution of effective cover has increased where fire suppression has resulted in dense understories of white fir and ponderosa pine. The current drought and recent insect and disease outbreaks are reducing the effectiveness of of this understory cover. The general trend is a overall decline in cover habitat.

Access for timber harvest has reduced the security of habitat for deer and elk. Road prisms have reduced the amount of available habitat and vehicle traffic on roads has displaced big game from habitat near open roads and in effect further reduced the amount of available habitat adjacent to roads. Roads have also increased the vulnerability of big game to hunter harvest.

Livestock compete with deer and elk for forage resources and space, especially in riparian areas and on winter range. Grazing has altered species composition and eliminated some preferred native herbaceous forage species, especially forbs. Loss of shrub vegetation, willows, from overgrazing and lowered water tables in riparian areas has altered the abundance and distribution of fawning cover and browse in these areas. Heavy livestock grazing removed vegetation competing with tree seedlings which allowed denser regeneration and reduced forage availability. Livestock have removed herbaceous cover and reduced fine fuels that carry fire through rangelands which improves forage quality and productivity for big game.

Land Use Effects, Condition Trend and Evaluation

Gradual growth of the early and mid-seral stands on all lands, future forest management with an emphasis on restoring and conserving late/old seral forests on Fremont NF lands, and continued fire suppression on all lands will most likely within twenty years reduce the levels of forage and increase cover habitat for deer and elk to quantities more consistent with historic conditions. Prescribed underburning should help maintain forage production, and compensate to some extent for the loss of forage from greater forest cover. It is conceivable that with the increasing risk of catastrophic wildfire from the continued drought, overstocked stands and the buildup of fuel loads from recent tree mortality caused by insect and disease outbreaks, future abundance of forage habitat may continue to exceed and cover remain below the historic levels. The recent Robinson Springs fire is indicative of the wildfire threat' that presently exists on the landscape at least in subshed Z.

Livestock grazing will continue to influence the availability, abundance and composition of forage for deer and elk, especially in meadow-riparian areas and on winter range.

In the absence of a transportation management plan, the trend will be toward the loss of more habitat and security, and greater vulnerability of deer and elk to harvest. If predicted road closures and obliterations are implemented, habitat availability and security will increase.

The elk population undoubtedly will continue to increase unless regulated by either sex hunting. More elk could potentially reduce the carrying capacity of the habitat for deer and precipitate a further decline in deer numbers. If elk numbers are limited to the threshold where this affect on deer occurs, then deer numbers should remain relatively stable. The population will fluctuate primarily in response to mortality from severe weather conditions, followed by high fawn recruitment during favorable conditions.

To increase deer numbers to help meet summer population objectives identified in the Forest Plan, management actions must be implemented to increase forage production and quality of both preferred herbaceous (primarily forbs) and shrub species on all seasonal ranges, particularly summer and transition.

Subshed A

The majority of the subshed is deer and elk winter and spring/fall transition range. The north and northeast ends of the subshed are summer range for both species.

Historic Condition

The landscape was dominated (53+%) by sub-optimum interior cover area, which comprised 62+% of all cover. Optimum cover area occurred over about 32% of the landscape along primarily natural meadows and comprised about 38% of all cover. Only 15% of the landscape was in forage area, primarily natural meadows, of which 14% was optimum. About 93% of all forage area was optimum.

The total amount of patch edge and density (both disturbance and natural) on the landscape was 46 and 6.3 miles, respectively. "True" patch edge on the landscape may be less because the landscape boundary was calculated as edge and the amount of true edge along the boundary was unknown. Road density information was not available, but is assumed to be lower than today.

Current Condition

The landscape is dominated (72%) by disturbance patch forage area created from even-aged regeneration timber harvest and the Round Butte fire in 1955. Equal proportions of the landscape and total forage area are in optimum and sub-optimum condition. Only 28% of the landscape is in cover area, of which less than 25% is optimum. About 90% of all cover area *is* optimum. Patch edge/density on the landscape increased 2.4 fold. Road density has reduced the availability and security of habitat below that which existed historically.

Subshed B

Most of the subshed is deer and elk summer range. The southwest corner of the subshed is deer spring/fall and elk winter range.

Historic Condition

Cover occupied 88% of the landscape. Optimum and sub-optimum cover area were just about proportionate. Only 12% of the landscape was in forage area, primarily natural meadows, of which 11% was optimum. About 94% of all forage area was optimum. The total length of patch edge and density (both disturbance and natural) on the landscape was 46 and 5.0 miles, respectively. "True" patch edge on the landscape may be less because the landscape boundary was calculated as edge and the amount of true edge along the boundary was unknown. Road density information was not available, but is assumed to be lower than today.

Current Condition

The landscape is now characterized by an almost proportionate amount of cover and forage *area.* Both cover and forage areas are predominately optimum, about 64 and 73% **of** the cover and forage areas, respectively. The 35% increase in forage and corresponding decrease in cover from the historic conditions is *a* result of the creation of disturbance patches from even-aged regeneration timber harvest. Patch edge/density on the landscape increased 2.8 fold. Road density has reduced the availability and security of habitat below that which existed historically.

Subshed C

The subshed is a fairly proportionate mix of deer and elk winter, deer spring/fall transition, and deer and elk summer ranges.

<u>Historic Condition</u>

Cover dominated 72% of the landscape. Optimum and sub-optimum cover area were just about proportionate. Only 28% of the landscape was in forage area, primarily early and mid seral pine disturbance patches created from, of which 20% was optimum. About 80% of all forage area was optimum. The total amount of patch edge and density (both disturbance and natural) on the landscape was 81 and 9.8 miles, respectively. "True" patch edge on the landscape may be *less* because the landscape boundary was calculated *as* edge and the amount of true edge along the boundary was unknown. Road density information was not available, but is assumed to be lower than today.

<u>Current Condition</u>

The landscape is now characterized by an almost proportionate amount of cover and forage area. Cover areas are predominately optimum, about 70% of the cover. Optimum and sub-optimum forage areas are proportionate. The 15% increase in forage and corresponding decrease in cover from the historic conditions *is* a result of the creation of disturbance patches from even-aged regeneration timber harvest. Patch edge/density on the landscape decreased 5.0% or 4.0/0.48 miles, respectively. Road density has reduced the availability and security of habitat below that which existed historically.

Subshed Z

Almost the entire subshed *is* deer and elk winter range and deer spring/fall transition range.

<u>Historic Condition</u>

The landscape was dominated (73%) by forage area. About 90% of the forage area was sub-optimum because most of the western half of the landscape *is* characterized by a large (11,000+ acres) contiguous patch of non-forest habitat. The Owen Butte fire in 1946 created another relatively large forage area. Optimum cover occurred in a slightly greater proportion (57%) than sub-optimum (43%). Total amount of patch edge/density and road density information was unavailable.

<u>Current Condition</u>

The landscape is now characterized by an even greater proportion (96%) of forage area from the creation of disturbance patches from two other large wildfires (Round Butte and Robinson Springs) and even-aged regeneration timber harvest. The amount of optimum forage areas has increased 19%. Cover has declined about 25% and now occurs on only 4% of the landscape. Cover areas are predominately optimum, about 99% of the cover. Patch edge/density information was unavailable. Road density has reduced the availability and security of habitat below that which existed historically.

Desired Condition

Habitat exists to support populations 5% larger than current condition.

Security habitat

Mule deer/summer range - Open road density *is* less than 2.5 mi/square mile.

Mule deer/transition and winter range - Open road density is *less* than 1.0 mi/square mile from December 1 to March 31.

Elk summer range - Open road density is less than 1.0 mi/square mile.

Edge habitat

Maintain the quality and quantity of edge habitat. Increase the quantity and quality of forage in the ecotone formed along edges. In existing burns and regeneration harvest units, 1-5 acre forage patches exist on sites with the greatest production of preferred forages near the edges of units.

In subshed Z, forage quantity and quality is improved with an emphasis on increasing the availability of grasses and forbs and creating a diversity of shrub age classes. About 55% of the landscape is in forage area. Created forage areas average less than 800 feet in width.

Shrub vigor is improved. Seedling establishment is improved and available forage for deer is increased.

Herbaceous plant regrowth is improved to replenish nutrient reserves in root systems for increased vigor and production to provide more forage for deer.

Riparian Habitat/Beaver

No assessment is available for historic or current beaver habitat conditions, or presence/absence populations. Also, no assessment of beaver populations in the watershed prior to 1935 was available.

Historic Condition

Native beaver populations were supplemented with transplanted animals. In the 1930's, only one site along the South Fork was known to support a beaver colony. In an attempt to increase beaver numbers on the Forest, a series of beaver transplants occurred from 1937 through 1946. Beaver were planted in Corral, Camp, Whitworth, and Ish Tish Creeks, and the SF Sprague. Following the transplants, beaver dispersed to suitable habitat on Brownsworth, Buckboard and Pothole Creeks, and several additional sites along the SF Sprague. Numerous new colonies became established in these stream systems.

The number of beaver colonies in Corral Creek also increased in number and expanded in range from the original transplant site. For some period beginning in the mid-1940's, beaver were more widely distributed, occurred in greater numbers and had more abundant and better quality habitat distributed over a larger area of the watershed than exists today.

Current Condition

Beaver are presently absent along three stream systems (Buckboard, Camp, and Pothole Creeks) where they occurred historically. Stream systems that currently support beaver include Corral and Brownsworth Creeks and the SF Sprague. However, beaver colonies are now fewer and less widely distributed than previously along these steam systems. Deciduous forage habitat and water are less available and abundant than what occurred historically.

Desired Condition

Existing beaver dams are maintained and new construction is encouraged by transplanting beaver to benefit riparian area objectives. Beaver habitat includes both deciduous and herbaceous forage species and water availability near active and historic dam sites *is* available to support well distributed beaver colonies that contribute to fully functioning riparian systems.

Land Use Effects, Condition Trends and Evaluation

Fire suppression, livestock grazing, and plant succession have contributed to the decline in beaver habitat and numbers. Fire suppression and plant succession have reduced the availability and abundance of some important deciduous forage species. Shade intolerant and fire associated species such *as* aspen, willow, and alder have undoubtedly declined in density and distribution as they are replaced by denser stands of shade tolerant coniferous species. Livestock grazing has reduced the availability and abundance of summer herbaceous and winter deciduous forage species and altered channel conditions and flow regimes to the extent that habitat needs for water may no longer be met in some stream systems. Down-cut and wide channel conditions also have reduced the site potential along some streams to support deciduous forage species.

The future trend in beaver numbers and habitat availability and suitability *is* predicted to be a gradual decline. As fire suppression continues and plant succession advances, forest stand management along riparian areas tends toward more uneven-aged systems over longer rotations, and livestock continue to compete with beaver for important forages and alter channel conditions by damaging banks, beaver habitat conditions and populations will experience a steady decline.

As beaver are lost from the system, wetland habitat *is* reduced along with associated plant and animal diversity and productivity, water and sediment storage and transport are altered, and nutrient cycling and decomposition dynamics change.

Management actions to stimulate an increase in production of deciduous forage species and increase the water table in riparian areas must be implemented if beaver numbers and distribution are to be increased in the future.

Aspen/red-naped sapsucker

Historic Condition

No assessment information was available on the occurrence of aspen forest over the landscape. However, it can be surmised that with more frequent, low intensity, and larger, high intensity wildfires, lower coniferous stand densities, and higher water tables along riparian areas, the abundance, distribution, and successful regeneration of aspen stands was probably greater during historic times prior to the period of heavy livestock grazing. More aspen in a diversity of age classes distributed over *a* larger area would have provided more available and suitable habitat conditions for aspen associated wildlife species, including the red-naped sapsucker.

Because mature aspen is the most preferred nesting habitat for sapsuckers, the numbers of sapsuckers may have been greater and their population more stable because of wider distribution. Intense livestock grazing would have contributed significantly to loss of aspen habitat *as* livestock damaged or destroyed aspen regeneration and contributed to the lowering of water tables along riparian areas.

Current Condition

Approximately 230 acres of aspen habitat occur on the landscape in almost equal proportion on both Fremont NF and other land. About 100 *acres are* in late seral condition with the remainder in early and mid seral condition. Canopy cover is greater than 41% on 165 acres, and less than 41% on the remainder. Late seral stands are generally in a decadent condition with little if any regeneration. Many stands are mixed with conifer species that contribute to the decline of the stands. Ungulate grazing continues to damage or destroy some of the limited regeneration that does occur. Most of the aspen stands occur along drainage bottoms, around spring and seeps, and on north aspects. Average patch size is 0.2 acres and maximum is 4 acres. The patches are highly fragmented and occur primarily in subsheds A, B, and C. Aspen density is greatest in A. The availability of preferred nesting habitat for sapsuckers has declined from historic times. This loss of preferred habitat for both species undoubtedly is a contributing factor limiting the populations and distributions of both species on the landscape.

Desired Condition

At least 400 acres of aspen habitat is present on the landscape.

Pure aspen stands exist with a dominance of aspen stems in both the mature and early seral stages. At least one-third of the existing mature stands are younger age classes and managed as replacement stands. Mature stands in poor condition receive priority treatment. Converted stands are protected from grazing by ungulates.

Mixed aspen stands maintain the present basal area ratio of aspen in the stand. Mixed stands with aspen in the poorest condition have highest priority for treatment.

Livestock grazing of aspen suckers *is* controlled, where necessary, until regeneration is a minimum of four feet tall to insure suckers sprout and replace the stand within five years after treatment.

Land Use Effect, Condition Trends and Evaluation

Aspen is gradually being replaced by conifers over time primarily as a result of natural succession and fire suppression. The decadent condition of mature aspen stands, the change in forest structure to denser conifer stands, encroachment of conifers into meadow areas and along riparian areas, and the buildup of debris on the forest floor has resulted in a decrease in the regeneration potential for aspen. Limited regeneration has occurred inadvertently as a result of regeneration timber harvest of mixed aspen/conifer stands. Frequently, the regeneration that does occur is either suppressed or eliminated by livestock and big game grazing. Where stream channels have been down-cut and/or widened and the water table lowered, the site potential for aspen may have been significantly reduced or permanently lost.

As aspen disappears from the landscape, preferred habitat for such species as beaver, red-naped sapsucker, and other aspen associated species will be lost. Populations and distribution of these species may shrink *as* well. Wildlife and habitat diversity will decline.

To maintain aspen as part of the landscape, regenerated stands should be protected from grazing and the most decadent, mature stands that appear to have resprout potential should be regenerated immediately. Where stream channels are down-cut but remnant aspen still persists, management actions should raise the water table and improve growing conditions for future aspen stands.

Goshawk Nesting/Rearing Habitat

Historic Condition

The earliest available information on goshawk presence is from 1974. Three active nesting territories were known to exist; two in subshed A and one in B. Nesting, fledgling, and foraging habitat for these goshawk pairs and their fledglings would have been near optimum as contiguous late seral forest interior habitat dominated the landscape in these three subsheds in the vicinity of the nest sites. Only forest cover in the Whiskey Spring territory was partially converted to mid *seral* by the Deming Creek fire in 1955. Disturbances from roads and timber harvest activities would have still been relatively low at the time.

Current Condition

Two of the three nesting territories known to exist are still active. The nest site on private land along Leonard Creek in subshed A was abandoned when late seral forest habitat in the territory was converted to early seral forest plantation as a result of regeneration timber harvest. The only late seral forest habitat remaining in the territory occurs as narrow strips along stream courses.

Goshawk surveys in suitable habitat in the vicinity of the old nest site from 1992 through 1994 failed to locate a new nest, but goshawk sightings near Camp Creek in the Wilderness northeast of the old nest site could be within the 1974 nest territory.

Habitat conditions around the other two nest sites have been altered since 1974 from the removal of late seral forest habitat through timber harvest. Late seral forest habitat at the Whiskey Spring nest site has been significantly reduced and fragmented and interior habitat has been eliminated. Forest cover on the Deming Creek burn now only provides marginal foraging habitat as trees mature. Suitable habitat at the Cottonwood Springs nest site has been reduced to small isolated islands surrounded by early/mid seral habitat with low potential. Current insect activity, particularly around Cottonwood Springs, has reduced both the canopy cover and stem density of large overstory and smaller understory trees in the territories. These changes have both positive and negative effects on habitat conditions. The effect of these habitat modifications at the nest sites on fledgling productivity is unknown.

Desired Condition

Suitable habitat is available for at least 3 goshawk nesting territories.

All active and historical nest trees are surrounded by 30 acres of the most suitable nesting habitat. Within a 0.5 mile radius of active or historic nest sites, two 30 acre areas of the most suitable nesting is maintained and three 30 acre areas are maintained as potential replacement (alternate) nest sites.

A 400 acre "Post fledgling area" (PFA) of the most suitable habitat is designated around every known active nest site. Late seral structural characteristics of forested stands are maintain. Canopy cover is 50% in ponderosa pine and 60% in pine associated and lodgepole pine. Openings of 2 acres or less are scattered throughout the area. Solitude opportunities exist in the active nest areas and PFAs during the breeding, nesting, and fledgling period from March 1 thru September 30. Road density is 2.5 miles/square mile or less.

Ponderosa pine and pine associated forest types within territories have 5-7 and 10-15 tons/acre of woody debris greater than 3" diameter.

Land Use Effects, Condition Trends and Evaluation

As tree plantations grow into the mid-seral condition class and salvage logging continues to remove dead and dying wood, habitat conditions for goshawk prey species will decline. This decline could reduce fledgling productivity. Large forest regeneration treatments on private lands in the future will continue to create edge habitat for prey species, but smaller openings created by unevenage prescriptions on Fremont NF lands should create more suitable prey and hunting habitat for goshawks. Future suitable nesting habitat on private lands under the assumed forest management prescription will only be of marginal quality. Nesting/rearing habitat on Fremont NF lands should be maintained in a condition similar to what currently exists in the short term, and potentially increase in abundance and quality over the long term.

Insect and disease outbreaks or catastrophic wildfire potentially could alter the present condition and amount (or totally eliminate) suitable nesting and rearing habitat but improve habitat conditions for prey species. The potential for the occurrence of these events has increased in the last 20 years. Predicted road closures will reduce disturbances to nesting and fledgling birds and potentially increase fledgling productivity.

Suitable habitat for 3 nesting territories should exist into the future, and similar quality habitat conditions should result in stable fledgling productivity. Removal of some understory forest cover with non-uniform spacing would help improve habitat conditions for nesting, rearing and foraging. A reduction in fuel loads with protection for snags and down wood would help protect late seral nesting habitat from destruction by catastrophic wildfire.

Western Sage Grouse

Historic Condition

One historic lek site occurs in the watershed in the Devils Garden area north of Devil Lake. The site was occupied by grouse in the late 1970's through at least mid-1980. No assessment of information was available on grouse occupancy prior to 1970, and no information was available on the historic habitat conditions around the lek site.

Current Condition

Infrequent, cursory surveys in the 90's have failed to locate any grouse on the site. It is possible that the site has been abandoned because of high sage mortality, and marginal nesting and rearing herbaceous habitat conditions in the general area in recent years. However, grouse are known to return to abandoned leks as habitat conditions improve around the site.

The lek site and surrounding area *is* scabrock flat. Most of the area is unvegetated. The plant community is characterized primarily by low sage with scattered juniper. Sage provides about 5-20%, grasses 20-30%, and forbs 10-20% ground cover. Extremely high sage mortality is evident in the area. Very little sage regeneration has been observed on the site.

Desired Conditions

Suitable habitat exists for occupancy of at least one lek site. The following desired conditions should be managed for within potentially suitable habitat within 1.5 miles of the lek site.

At least 50% of the annual herbaceous vegetation (by weight) is retained prior to mid-September.

Sagebrush composes 20-30% of the vegetation or 5000-10,000 plants/acre.

Some sagebrush stands have 20 to 40% canopy cover for nesting and brood-rearing.

Springs and reservoirs are fenced; water for livestockis piped to an outside trough to stimulate production of forbs and grasses around the wet areas.

Herbaceous stubble height is 4" and stands have tall grass cover at *a* height greater than 18 cm.

Maintain or increase the status of populations and habitats.

Land Use Effects, Condition Trends and Evaluation

Current and historic ungulate grazing (both livestock and deer) have undoubtedly altered the plant composition, structure, and cover in the lek area to the detriment of grouse reproduction and survival. Grazing has reduced nesting and escape cover. Forbs, an important spring/summer forage for adults and young, also have been reduced in cover.

Until the area around the lek site is once again occupied by mature sage cover and more suitable herbaceous cover for nesting and rearing, grouse probably will not use the site. If limited use does occur, chick productivity probably would be low and not enough to maintain the population.

Ungulate grazing will continue to reduce nesting, escape, and herbaceous forage cover. Livestock grazing intensity would have to be reduced and *season* of use changed to improve habitat conditions for grouse occupancy and higher productivity to increase population size and stability.

Peregrine Falcon Nesting Habitat

Historic Condition

Local falconers say peregrines have historically nested in the vicinity of Gearhart Mountain. However, peregrine survey information on the Bly District is limited and no recorded sightings of peregrines are known.

There has existed the potential for two peregrine nesting territories; one site around Gearhart Mountain and the other along Brownsworth Creek canyon. In 1980, both sites were rated as suitable, having low potential for occupancy. Habitat for prey species and hunting within the Gearhart Mountain Wilderness area was marginal because the landscape was dominated by late seral forest. The Brownsworth territory was predominately open sage habitat and provided abundant habitat for prey species and hunting.

The Round Butte wildfire in 1955 significantly added to the availability of habitat for prey and hunting. Both territories were highly secure from disturbance since road densities, logging activities, and recreational *use* of the trails in the Gearhart Mountain Wilderness probably were low.

Current Condition

No peregrine surveys of the two potential nesting territories have been conducted since 1980. It is unknown if peregrines presently occupy either site. New criteria for suitable peregrine habitat has increased the possibility that either site may be more suitable for occupancy than originally thought.

Habitat for prey species and hunting within the Gearhart Mountain area has improved with the removal of late seral forest and the corresponding increase in more open early seral forest cover types *as a* result of regeneration timber harvest. Disturbance sources have increased with the higher road and trail density, and greater recreational use of the Gearhart Mountain Wilderness area.

Removal of late seral forest through regeneration timber harvest also has improved habitat for prey species and hunting within the Brownworth territory.

The growth of forest cover on the Round Butte burn has gradually reduced the suitability of habitat for prey and hunting here. Disturbance sources also have increased with the higher road density and more logging activities.

Desired Condition

Suitable habitat conditions are present for 2 occupied nesting territories.

Solitude is available within 1.0 miles of active nest sites during the courtship, nesting, and fledgling period (February 1 thru August 15).

Maintain or increase the status of populations and habitats.

Land Use Effect, Condition Trends and Evaluation

Habitat for prey species and hunting within both territories will gradually diminish as early and mid-seral forest stands mature until the next timber harvest entry on private lands. Large open hunting areas on Fremont NF lands will not occur in the future under the predicted forest management scenario. This loss of prey and hunting habitat will reduce the suitability of habitat for peregrine occupancy.

Insect and disease outbreaks or catastrophic wildfire potentially could alter the present condition and amount of habitat for prey species and hunting at any time. The potential for the occurrence of these events has increased in the last 20 years. Disturbances in the Gearhart Mountain area near potential nest sites will increase and reduce habitat suitability as recreational use of the Wilderness area increases. Predicted road closures will reduce disturbances and increase habitat suitability near potential nest sites in the Brownsworth territory and within the hunting area of both territories.

Suitable habitat for 2 peregrine nesting territories should exist into the future, but the availability, abundance, and condition of prey and hunting habitat my decline.

CHAPTER V

INTERACTIONS

V. INTERACTIONS

The issues presented in the South Fork Watershed Analysis interact because they are related by 1) common effects of management and non-management actions, and 2) common ecologic processes. Management and non-management actions may affect more than one issue; issues are the result of more than one management or non-management action. Table I-1 summarizes the interaction between issues and management and non-management actions.

A. Management and Non-Management Actions

Management actions include timber harvest, grazing, road construction, and fire suppression. Non-management actions include stochastic fire and flood events, competition between native and non-native species and weather cycles. Management and non-management actions produce environmental effects. These effects, such *as* sediment, compaction and reduction in plant cover are summarized in Table 1-2. Management and non-management activities may produce more than one environmental effect. For example, high road densities and roads located within riparian zones have produced direct effects of 1) access, 2) channeling, 3) reduction in plant cover, 4) compaction, and 5) sediment in the South Fork Sprague Watershed (Table 1-2).

B. Common Ecologic Processes

The direct effects of management and non-management actions influence ecologic processes. For example, the direct effect of past tree removal within riparian zones influences the ecological processes of stream shading. (Table 1-2). Stream shading has an effect on more than one issue. For example, stream shading provides thermal regulation for salmonid habitat (Issue 4) and is directly related to stream temperatures (Issue 1). The manipulation of a given ecological process is common to several management and non-management actions. For example, stream shading is not only influenced by tree removal from logging, but also grazing and the associated plant removal on road prisms within riparian areas. Table 1-2 summarizes the common ecological processes related to management and non-management actions.

C. Summary

There is *a* direct cause effect relationship between management and non-management actions and issues. Figure I-1 summarizes the interaction between management actions and issues. As described above, management actions produce environmental effects. These environmental effects influence ecologic processes occurring in the watershed. The manipulation of ecologic processes produces outcomes and effects on watershed resources.

Over time, these effects and outcomes produce trends. Figure 1-2 illustrates the interaction between the management action of grazing and the issue of water temperature and salmonid populations.

For example, grazing directly removes plants and increases compaction within riparian zones. These activities influence such ecological processes as stream shading, bank stability, infiltration, soil structure and stream flow.

The manipulation of these processes has resulted in temperature increases, bank damage, sedimentation, pool filling and cobble filling. Areas of high stream temperature and bank instability have been described in the issues section. The cumulative effect of these processes, or trend, is a decline in salmonid fish habitat and reduced productivity of riparian areas. This trend can be expected to continue. As described in the beneficial uses section, domestic animal use on the majority of the watershed is at or near peak levels from the early 1900s. Table 1-2 summarizes the interaction between other management and non-management activities, their influence on ecological processes, and effects on resources.

TABLE I-1, MANAGEMENT & NON-MANAGEMENT INFLUENCE ON ISSUES IN SOUTH FORK WATERSHED

	Issue 1 WATER QUALITY	Issue 2 RIPARIAN CONDITION	Issue 3 WATER QUANTITY	Issue 4 NATIVE FISH HABITAT	Issue 5 WILDLIFE & VEGETATION
Trends	Reduction in quality; exceeds State standards for temperature and dissolved oxygen	Reduction in function; unstable riparian conditions	Base flow decrease; peak flow increase	Reduction in native species populations; Increase in non-native populations	Reduction in function and core matrix; change in composition; late seral and deciduous plant decrease
Management Causes	Road location Road density Cattle compaction Cattle vegetation Logging riparian	Road location Cattle compaction Cattle vegetation Logging riparian	Road location Road density Cattle compaction Logging compaction Tree selection Fire suppression	Road location Road density Cattle vegetation Logging riparian Tree selection Fire suppression	Road density Cattle vegetation Logging riparian Fire suppression
Non-Management Causes	Basin orientation Drought	Fire event Flood event	Fire event Drought	Non-native competition	Fire event

TABLE I-2, MANAGEMENT & NON-MANAGEMENT INFLUENCE ON ECOLOGICAL PROCESSES & OUTCOMES

ACTIVITY	DIRECT EFFECTS	ECOLOGICAL PROCESSES	RELATED OUTCOMES; RESOURCE EFFECTS, & EFFECT ON ISSUES
Road location (riparian)	Increase in sediment and turbidity	Imbededness, Pool maintenance	Reduction in salmonid spawning and pool habitat, increased competition for remaining habitat.
	Increase in compaction and overland flow	Infiltration, Soil productivity	Increased peak flows, increased kinetic energy in stream channel, increased stress on stream bank stability. Lower base flow during summer, changes in soil structure leading to lower site productivity, reduced infiltration. Lowering of water table, decline in deciduous plant species.
	Reduction in plant cover	Stream shading, Bank stability	Higher stream temperatures, competitive advantage to fish species tolerant of high temperatures, such as brown trout. Lack of plant root mass leading to localized stream bank instability. Loss of LWD source, loss of detritus source, reduction in riparian function.
Road density (upland)	Channeling, and sediment production	Infiltration, Overland flow, Erosion	Precipitation from storm and runoff events accelerated out of watershed along road prism, increase in peak flow, increase stress on stream bank stability. Decrease in base flow. Lowering of water table, decline in deciduous plant species.
	Access	Fragmentation, Disturbance	Increase in edge habitat, decrease in snags along roads, decrease in habitat security, loss of wildlife habitat, avoidance of wildlife habitat.

TABLE I-2 MANAGEMENT & NON-MANAGEMENT INFLUENCE ON ECOLOGICAL PROCESSES & OUTCOMES (CONT.)

ACTIVITY	DIRECT EFFECTS	ECOLOGICAL PROCESSES	RELATED OUTCOMES; RESOURCE EFFECTS & EFFECT ON ISSUES
Grazing (riparian/ soils)	Stream bank trampling	Bank stability, Bank erosion	Increase in sediment from hoof sheer. Increase in stream width to depth ratios, increased stream temperatures.
	Compaction	Infiltration, Overland flow, Soil productivity	Increased peak flows, increased kinetic energy in stream channel, increased stress on stream bank stability. Lower base flow during summer months. Decline in soil structure leading to decrease in site productivity.
Grazing (riparian/ vegetation)	Removal of shrubs and forbs	Stream shading, Bank stability, Plant diversity	Higher stream temperatures, competitive advantage to fish species tolerant of high temperatures, such as brown trout. Loss of detritus source, reduction in bank building and riparian function. Reduction in aspen and willow regeneration leading to reduction in beaver and red-naped sapsucker habitat. Conversion of site potential to non-preferred forage species. Lowering of site potential and productivity. Lack of plant root mass leading to stream bank instability. Loss of wildlife cover in riparian habitat. Reduction in wildlife diversity.
Logging (riparian)	Removal of large trees	Stream shading, LWD	Higher stream temperatures, competitive advantage to fish species tolerant of high temperatures, such as brown trout. Lack of plant root mass leading to stream bank instability. Loss of wildlife cover in riparian habitat. Loss of LWD source leading to reduction in pools and stream complexity; reduction in riparian function. Increase in sedimentation.

TABLE I-2 MANAGEMENT & NON-MANAGEMENT INFLUENCE ON ECOLOGICAL PROCESSES & OUTCOMES (CONT.)

ACTIVITY	DIRECT EFFECTS	ECOLOGICAL PROCESSES	RELATED OUTCOMES; RESOURCE EFFECTS, & EFFECT ON ISSUES
Fire Suppression	Increase in stand density	Stand composition, Succession, Stand function	Increase in young fir trees, increase in stand basal area, increase in evapotranspiration, decrease in base flow. Decrease in deciduous species due to competition, increase in cover, decrease in forage. Large trees stressed due to competition with young understory, increasing susceptibility to forest pathogens and insects.
Fire event	Reduction in plant cover	LWD, Overland flow, Soil productivity, Erosion	Long term reduction in LWD source, reduction in pool habitat and riparian function, short term reduction in riparian shade, increase in stream sediment and temperatures. Reduction in LWD source for soil productivity. Decrease in tree canopy and increase in spring runoff events.
Non-natives (brown & brook trout)	Competition with native salmonids	Hybridization, Competition	Brook trout hybridization with bull trout; brook and brown trout competition with bull and redband trout.
Flood event	Increase runoff or peak flow	Overland flow Stream bank stability, LWD	Increase in kinetic energy to stream channel, erosion occurs if stream banks are already unstable. Reduction in LWD, pool habitat and riparian function.
Weather cycle	Decrease in precipitation during drought	Hydrologic budget	Reduction in base flow, decrease in perennial miles of stream, overall decrease in fish populations and distribution. Increase in water temperature.

CHAPTER VI

MANAGEMENT RECOMMENDATIONS

VI. MANAGEMENT RECOMMEDATIONS

The following are recommendations developed by the core team members:

Water Quality

Apply site-specific BMPs to activities with the potential to affect water quality or quantity.

Riparian

Manage livestock grazing to met Forest Plan Standards and Guidelines and to restore riparian vegetation to the desired condition. Manage livestock through herding, salting, fencing, or changes in numbers or season of use. Fence seeps and springs to prevent soil damage and to improve the vegetative condition. Provide upland water sources for livestock to improve distribution of use.

Protect riparian areas and streams by implementation of the timber sale screens or by equally protective buffers of 300 feet for fish-bearing streams, 150 feet for perennial nonfish-bearing streams, and 100 feet for intermittent nonfish-bearing streams. Adjust buffer widths as necessary during site specific project planning.

Reduce the number of roads, both system and nonsystem, within riparian areas. Emphasis should be given to roads parallel to the channel. Obliterate, block, and restore these areas where feasible in order to reduce impacts on riparian and meadow areas. Riparian areas should not be used for landings, skidroads, and haul roads. Also, the bottoms of ephemeral draws should not be used for skidtrails, landings, or as road locations. Equipment should not be permitted to move up and down these draws, however, limited perpendicular crossings could be permitted.

Increase stream shading on selected stream segments through planting of riparian vegetation (coniferous and/or deciduous species).

General Forest

Management activities on federal land should protect the late and very late seral staged stands to balance the early to mid-seral stands on private land. Reducing the overstocking in the understory by harvest of white fir and thinning smaller trees will reduce the impact on older trees. However, the younger ponderosa pine stands need to be thinned to move them into displaying late to very late characteristics as quickly as possible. Late and very late ponderosa pine stands that are over 120 square feet of basal area appear to be at risk, especially if over 60 square feet of basal area is in the understory and composed of more tolerant white fir.

Treat late and very late stands to prevent further decline. Stands that are overstocked with more than 80 square feet of basal area in the under-story should be recognized *as* the highest priority for treatment, over and above the ones that are experiencing increased mortality.

Promote ecosystem restoration arid health throughout the watershed. Cooperate with other agencies and interested private landowners through cooperative agreements and joint ventures.

In riparian areas that are clearly experiencing forest health problems (overcrowding and stress of preferred conifers *is* occurring, mortality is **occurring or insect/disease** activity is above sustainable levels) conduct thinnings of understory vegetation. Treatments are to be conducted through low impact methods (hand felling and/or restricting the use of equipment) or through the use of prescribed fire. Treatments would be designed to meet clearly defined aquatic and riparian objectives.

Potential projects for the forested resource involve protection of the late seral component by reducing competition from the understory. Most of the stands that have *a* canopy closure of 41 to 70% south of the Gearhart Mountain Wilderness are in the late to very late seral staged stands. The pine stands should have the understory thinned to less than forty square feet of basal ***area*** **and** the total stand basal area kept under one hundred twenty square feet. This especially is true for the Ponderosa pine, Lodgepole pine and the **mixed** PIPO/PICO stands.

White fir stands along Coleman rim should be thinned to prevent or slow the spread of annosus. These stands are overstocked and should be thinned to less than one hundred forty square feet of basal area. All white fir stumps should be boraxed to prevent root disease spread. Thinning in the pine communities of the lower portion of the watershed in federal ownership, should be reduced to an intensity that leaves about sixty square feet of basal area in the mid-seral component of the stand. This will force the development of older tree characteristics, specifically size, *as* quickly *as* possible.

The increased use of fire in the watershed to control species composition, fuel loading, and plant community stability is a likely project. Most of the pine communities in the southern portion and the mixed species stands south of the Gearhart Mountain Wilderness, will benefit from a return to the natural fire regime.

Vegetation Composition

The forested areas within the watershed should contain 14% late successional stage forests. Harvest treatments and vegetation management should be aimed at creating important late successional attributes of old growth by accelerating the "replacement late successional condition" where appropriate.

Both horizontal and vertical structural diversity should be achieved through a silvicultural prescription that considers stand dynamics and vegetation response in the analysis. Management activities should focus on restoring Ponderosa pine and other seral species to sites where they are well adapted.

Confine harvest activity on National Forest lands in the SFS to only those treatments needed to reduce stand densities and improve forest health. Treatments would emphasize thinning of understory white fir and leaving large pine species.

Management activities including timber harvest and prescribed fire should retain canopy closures that approximate sustainable conditions for that vegetation type, and be consistent with other resource concerns.

Insects and Disease

Stands which are currently stocked above the carrying capacity for the site will continue to experience mortality from the three bark beetle species which are prominent in this watershed. Some general risk rating and predictions for bark beetles is based on available stand exam information in the watershed. This could be done by using the recommended stocking levels described in Cochran, et al (1994) which are based on stand density index. The ratio of existing stocking to recommended stocking would serve as a useful index for identifying stands with a high likelihood of experiencing changes due to bark beetles.

A potentially significant disturbance agent in the future could be the Douglas-fir tussock moth, 0. pseudotsugata. This insect reached outbreak populations in the 1960's in the Drews Valley and killed many white fir trees. Dense fir stands on dry sites could be severely affected by this defoliator.

Fire

Judicious use of controlled fire is often the most acceptable means of returning a watershed to naturally fire occurring regime in stable plant communities. Fire should be used in the watershed to maintain a balanced vegetation pattern that is dominated by ponderosa pine.

To move the watershed to the desired condition and mimic a natural fire regime, a prescribed fire rotation needs to be implemented. The areas that are fire-climax Ponerosa pine type in the watershed should be burned on a mosaic pattern on a twelve to fifteen year cycle. Most of this type would be covered in a ninety year rotation. Eight to twelve thousand acres in a mosaic pattern would be burned per decade.

The lack of underburning in these stands also contributes to the competitive pressure on the older Ponderosa pine overstory. These stands should be returned to a natural low intensity fire regime. Lodgepole and true white fir or mixed conifer stands should be thinned and have the fuel mechanically treated to protect the existing late seral stands and move the mid seral stands into the late stage as quickly as possible.

Underburning to control species and fuel loading will not accomplish these objectives and most likely cause stand replacement. Increasing the vigor of the stands through thinning and underburning will return them to a more natural balance of endemic insect activity.

Aggressively conduct emergency rehabilitation activities to restock riparian and upland areas affected by wildfire. Limit salvage activities within SMUs, particularly those that cause surface disturbance or compaction.

Late/old Seral Forest

Design and implement forest management actions to move toward and maintain the late seral composition, structure and pattern characteristics described in the desired conditions including the following:

Implement mechanical and prescribed burn treatments to restore open park-like stands (average canopy density less than 30%) of late seral ponderosa pine with average tree diameters greater than 15". Thin overstocked understories, reduce accumulated duff, and culture non-uniform multi-storied pine understories and large diameter live trees and future snags.

Establish Riparian Habitat Conservation Areas and manage forest stands within these areas to conserve late seral forest as a network of corridor habitat.

Manage forest stands within the Coleman Rim roadless area to develop and/or conserve late seral forest as interior habitat.

Manage forest stands within the South Fork Sprague River Special Management Area to conserve late seral forest as corridor habitat. When appropriate within this late seral forest corridor, implement small patch regeneration treatments to restore stands of shade intolerant deciduous species such as alder, aspen, dogwood, and willow. For this special management area and the previous two items mentioned, also implement non-uniform thinning and prescribed burn treatments where necessary to control understory stocking, reduce fuels and develop multi-storied stands, restore open park-like ponderosa pine stands where appropriate and culture the development of large diameter live trees and future snags.

Manage all "other" late/old seral forest habitat mapped in the inventory completed in 1994 to conserve its character *as* interior and corridor habitat *as* described in the desired conditions.

Manage for an old growth restoration zone (600-1200 feet) surrounding presently designated old growth reserves and other old growth to buffer and increase forest interior habitat. Design and implement prescriptions to develop and maintain late/old seral forest characteristics within the zone.

Manage for larger additional or replacement designated old growth stands within 1.5 miles of existing designated and "other" old growth stands where the distance between these stands presently exceeds 1.5 miles.

Map connectivity corridors among designated, and proposed late/old seral stands. Where gaps occur, manage forest stands to move toward the structure described in the desired conditions.

Culture selected early and mid seral ponderosa and pine associated forest stands for late seral forest characteristics to develop a three-tiered management strategy for late seral forest habitat.

Design and implement forest management prescriptions featuring progressive or cluster treatments, particularly for shelterwood and seed tree regeneration units, from existing scattered nuclei to reduce risks to late seral forest cover associated with edges, gaps, fragmentation, and the amount of maintained roads.

Design and implement prescriptions for all forest stands that culture the development of relic large diameter live trees and future snags.

MI/Keystone Species Associated with Unique Habitats

Dead trees and down logs/ all cavity nesters

Manage forest stands to maintain or restore the snag, green replacement tree and down log composition, densities, distribution and sizes described in the desired conditions.

In snag deficient areas, if feasible, create snags from live trees and/or manage adjacent forest stands for higher densities to partially compensate for the deficient areas. Utilize top blasting and girdling to create snags.

Culture green replacment trees in early and mid seral stands to develop future large diameter snags at the desired species composition and densities for the full forest rotation.

Protect down logs and snags with fuel breaks where necessary to maintain the desired conditions when implementing prescribed burn treatments.

Aspen Habitat

Manage to regenerate, protect and increase aspen habitat *as* described in the desired condition. Implement mechanical and/or prescribed burn treatments to promote suckering.

Beaver

Manage livestock stocking rates, season of use and grazing systems to restore both native deciduous and herbaceous forage species, and water availability near active and historic dam sites where these factors may be limiting beaver re-colonization or productivity.

Transplant beaver into historic or suitable habitat where such actions benefit riparian area objectives.

Goshawk nesting/rearing habitat

Manage forest stands within goshawk nesting territories as described in the desired conditions to maintain long-term nesting, rearing and foraging habitat.

In nest areas and PFA's with overstocked understories and/or high fuel loads, thin from below with non-uniform spacing using either mechanical and/or prescribed fire treatments.

Maintain solitude in the active nest areas and PFAs during the breeding, nesting and fledgling period from March 1 thru September 30. Manage road densities to Forest Plan standards of 2.5 miles/square mile.

Leave 5-7 and 10-15 tons/acre of woody debris greater than 3" diameter in ponderosa pine and pine associated forest types, respectively, within territories.

Big game

Design and implement management actions to improve habitat security and increase forage abundance and nutrient quality.

Mule deer/summer range - Open road density less than 2.5 miles per square mile.

Mule deer/transition and winter range - Open road density less than 1.0 mile per square mile during the critical winter period, November 15 to April 15.

Elk summer range - Open road density less than 1.0 mile per square mile.

Design thinning prescriptions with non-uniform spacing to maintain patches of forage and cover, and variable densities of cover.

Implement prescribed fire, mechanical treatments and plantings on winter/transition ranges to reduce juniper and big sage densities, improve shrub age class diversity and production, and herbaceous plant production and nutrient quality.

Implement prescribed underburns on all seasonal ranges to increase herbaceous plant and shrub production.

In existing burns and regeneration harvest units, maintain 1-5 acre forage patches on sites with the greatest production of preferred forages near the edges of units.

Implement early season grazing strategies on winter/transition ranges to improve shrub vigor and seedling establishment, and increase herbaceous plant regrowth and annual shrub production for greater forage availability.

TES Species and Habitats

Western sage grouse -

Manage livestock stocking rate, season of use and grazing system on rangeland within 1.5 miles of the lek site to move toward and maintain the desired conditions described for sagebrush and herbaceous vegetation, and water sources.

Peregrine Falcon

Maintain solitude within 1.0 miles of active nest sites during the courtship, nesting and fledgling period from February 1 thru August 15.

Roads

Revise Road Management Objectives (RMOs) to reduce road densities and to determine appropriate surfacing for roads. Establish RMOs using interdisciplinary input and consideration for all resource concerns.

Restrict wet-season use of unsurfaced roads by implementing seasonal road closures. Upgrade surfacing of natural-surfaced roads to other types in order to reduce erosion.

Design, coordinate, and implement road closures and obliterations to move road densities less than 2.5 miles/square mile. Road obliteration should be done by a combination of both subsoiling and/or obliteration depending on the terrain. Subsoiling with a winged type implement may be sufficient on slopes up to 15 per cent. On steeper terrain complete obliteration (involving such equipment as an excavator) may be required to pull berms back and restore the hydrologic function of the slope.

Focus efforts to reduce the number of roads that cross streams or are in close proximity to streams. Upgrade culverts to accommodate a 100-year flow on salmonid-bearing streams to reduce the risk of failure. Culverts that are barriers to fish migration should be replaced with arches or fish passage culverts.

Soils

Meet Forest Plan Standards for detrimental soil impacts and road densities on a cumulative effects basis. Subsoil, seed, fertilize, and mulch temporary roads, skidtrails, spur-roads, and landings where necessary to reduce compaction and increase infiltration. Seed with native species as appropiate and depending on availability.

B. Possible Projects (Restoration Projects)

South Fork Sprague Mainstem

Road Obliterations (lower reaches)

T37S, R15E, Sec.2 - 037 Rd
Presently there are riparian road obliteration opportunities within the upper reaches.

Riparian Revegetation (all reaches)

Temporarily exclude livestock from the South Fork Sprague riparian area until an upward riparian trend is reestablished in T375, R15E, Sec. 1,2,3 and 8 and also T36S, R16E, Sec 12,14 and 23. Restore degraded habitats by planting alder, willow, and conifers in areas currently lacking stream shading and stream bank stability. T37S, R15E, Sec 1,2,3 and 8 and T36S, R16E, Sec 12,14. (Pothole, Swede/Deming and Blaisdell Allotments).

Large Woody Debris (LWD) Restoration (lower reaches)

Restore LWD in stream channels with **less** than desired condition. This includes cutting trees, transporting them to the sites, structure design and placement in T37S, R15E, Sec 1,2 and 3.

Native aquatic species restoration may be necessary in the future as bull trout populations increase within the bull trout refuge areas (upstream from established barriers).

Brownsworth Creek

Road Obliterations (lower reaches)

T37S, R15E
T36S, R15E
104 road in sections 2,36.
105 road in sections 1,2,.
037 road in section 2.

Riparian Revegetation (all reaches)

Continue temporary exclusion of cattle from the Brownsworth riparian area until riparian vegetation shows an upward trend in T36S, R16E, Sec 8, 16, 21, 29, 30 and 31. It should continue until young willows are established. This action should include planting cottonwood and conifers in areas currently lacking stream shading and stream bank stability T37S, R15E, Sec 1,2 and T36S, R15E, Sec 36 (Pothole and Swede/Deming Allotments). This entails rest from livestock grazing until riparian vegetation recovers and then assessing the grazing strategy to assure it is consistent with increasing riparian shrubs density.

Large Woody Debris Restoration (lower reaches)

Restore LWD in stream channels with less than desired condition. This includes cutting trees, transporting them to the sites, structure design and placement in T37S, R15E, **Sec** 2,36.

Native Aquatic Species Restoration

Restore habitat for bull trout and redband as directed in the bull trout conservation strategy. Barriers need to be constructed at suitable locations, then nonnative fish species removed from T37S, R15E, Sec 1,2 and T37S, R15E, Sec 36.

Leonard Creek

Road Obliterations (upper reaches)

T36S, R16E
098 road in sections 7-8. 097 road in sections 7-8.
099 road in sections 7-8. 020 road in sections 7-8.
Cost share obliteration with Weyerhaeuser for 020 sec 17-20.
Remove any culverts from obliterated section of road.
(Lower reaches are Weyerhaeuser Co. lands)

Riparian Revegetation (all reaches)

Continue temporary exclusion of cattle from the Leonard riparian area until riparian vegetation shows an upward trend in T36S, R16E, Sec 7, 8, 17, 19, 20. It should continue until young willows are clearly established (Pothole Allotment). When the area is proposed for grazing the strategy should be implemented only if it is shown to increase riparian shrubs.

Hammond Creek

Riparian Revegetation

Continue temporary exclusion of cattle from the Hammond riparian area until riparian vegetation shows an upward trend in T36S, R16E, Sec 30. It should continue until *a* clear upward trend has been reestablished within the riparian area as indicated by establishment of young willows.

Camp Creek

Road Obliterations

T36S, R16E
016 road in sections 9,10,15.
152 road in sections 9,15,16.
157 road in sections 9,15,16.
154 road in sections 9,15,16.

Native Aquatic Species Restoration

Restore habitat for bull trout and redband as directed in the bull trout conservation strategy. Barriers need to be constructed at suitable locations, then nonnative fish species removed and bull trout reintroduced T36S, R16E, Sec 9,10,14,15.

Corall Creek

Riparian Revegetation (lower reach)

Manage livestock to restore riparian vegetation to the desired condition. This includes planting willow in areas currently lacking stream shading and stream bank stability in T36S, R16E, Sec 11 and 14 (Pothole Allotment).

Buckboard Creek

Road Obliterations

T36S, R17E
233 road in section 30.
188 road in section 30.
189 road in section 30.
190 road in section 30.
191 road in section 30.
194 road in section 30.
195 road in section 30.

Riparian Revegetation (upper reaches)

Strict monitoring of riparian vegetion in the Buckboard riparian area is required. Past monitoring has been insufficient to indicate when cows needed to be moved in T36S, R16E, Sec 30 and 32. Management may also include planting alder, willow, and conifers in areas currently lacking **stream shading** and stream bank stability in T36S, R17E, Sec 30 and 32 (Pothole Allotment).

Large Woody Debris Restoration (upper reaches)

Restore LWD in stream channels with *less* than desired condition. This includes cutting trees, transporting them to the sites, structure design and placement in T36S, R17E, Sec 30 and 32.

Pothole Creek

Road Obliterations

T37S, R17E
138 road in sections 8-9.
113, 111, 114 **roads** in section 7.
All remaining roads in section 9.

Riparian Revegetation (All reaches)

Riparian planting is not necessary but excessive utilization by cattle has occurred recently in this drainage and needs to be closely monitored in T37S, R16E, Sec 6,8,9,10,12 and 15. **Key use** areas should be designated in the meadows of **Sec** 10 and 15 (Pothole Allotment).

Large Woody Debris Restoration (lower reaches)

Restore LWD in stream channels with less than desired condition and less pools than desired condtion. This includes cutting trees, transporting them to the sites, structure design and placement in T37S, R16E, *Sec* 12.

Definitions

Road obliteration implies using a subsoiler or tracked excavator to obliterate the road prism, thus shattering compaction and allowing for the natural or artificial revegetation of the road bed. Areas with cut and fill slope would have the fill slope pulled back to its former angle of repose. Areas without cut and fill slopes would be subsoiled. Areas with steep slopes directly adjacent to important streams would be seeded and erosion matting installed.

Riparian revegetation implies actions taken to restore riparian shrub and tree communities. This would involve silvicultural prescriptions for planting riparian vegetation. In addition to deciduous trees and shrubs, conifers should also be planted to provide for long term shading and LWD recruitment. Any revegetation efforts would have to include provisions for controlling livestock (fencing etc). Grazing management changes imply changes in the way grazing is conducted in certain areas. This could mean fencing sensitive areas, developing additional pastures or rest.

Large woody debris placement implies moving offsite or adjacent LWD to the project area and anchoring within the stream channel to improve aquatic habitat complexity and fish habitat.

Native aquatic species restoration implies building barriers to keep nonnative species of fish out of habitat for bull and redband trout and the removal of nonnatives. This will occur within habitat presently and formerly occupied by native fish species.

C. **Monitoring Recommendations**

Develop a water quality monitoring plan to monitor trends in sediment and temperature and to "spot check" turbidity, pH, conductivity and nutrients. Collect baseline data to determine dissolved oxygen and bacteria levels throughout the SFS and compare to State and Forest Plan standards. Determine trend of watershed by monitoring water quality data at the SFS baseline station.

Continue to monitor stream temperature levels in order to determine trends and compliance with State temperature standards.

Monitor the implementation and effectiveness of BMP's, mitigation measures, and constraints for all management activities on a representative basis.

Annually monitor watershed restoration projects in order to determine effectiveness and maintenance needs.

Inventory levels of detrimental upland soil conditions during project planning for the purpose of assessing preexisting conditions and include this information within each specialist's report. Equate detrimental soil conditions from all activities, including system roads, along with Equivalent Clearcut Area and stream channel/riparian conditions to assess cumulative impacts.

Implement the "Meadow Riparian Monitoring Guide" for all "Key Areas" within the Southfork of the Sprague River Watershed. Parameters to be measured include: 1) Stubble height; 2) Herbaceous vegetation utilization; 3) Shrub utilization; 4) Soil Condition; 5) Streambank stability; and 6) Compliance monitoring.

Evaluate these parameters in relationship to season of use, grazing strategy, and numbers. Grazing utilization levels need to be closely monitored in riparian areas in the SFS and its tributaries.

Determine the presence/absence of fluvial redband trout and their preferred spawning tributaries (most importantly lower Brownsworth). Map "hot spot" spawning and rearing habitat.

Determine populations of native fish species such as redband trout, marbled sculpin and lampey species within the SFS.

Determine bull trout spawning and juvenile escapement trends using redd counts and possibly traps.

Study bull trout/brown trout interactions in Brownsworth Creek to determine the displacement mechanism.

Establish a macroinvertebrate monitoring network in the watershed to monitor trends in water quality (nonpoint source pollution) and aquatic habitat. Collect macroinvertebrate data on: 2 sites in SFS (upper and lower), 2 sites in Brownsworth Creek (upper and lower reaches) and 1 site on lower Camp Creek.

Emphasize monitoring of late and very late seral staged stands. They need to be observed on an annual basis to determine treatment needs. The late and very late seral stands in the wilderness can be observed.

Basal area and species composition in the understory are the most critical elements to monitor. Insect activity and outbreaks usually indicate areas that have become susceptible and not be able to benefit from preventative treatment. This will identify areas of potential salvage. Fuel inventory in the late and very late stands will also need to be monitored to facilitate the frequency of fire return through controlled low intensity underburning. Stocking surveys in the younger stand will need to be done to measure their growth rate and estimate the thinning regime that will move them into the late seral stage.

Stand conditions should continue to be monitored through the *use* of remote sensing such as change detection using the ISAT satellite imagery, aerial photography, and annual insect outbreak monitoring flights. Stand exams of the late and very late seral stands will be necessary to formulate specific prescriptions to reduce the competitive effects of the understories.

D. Data Gaps

Using Map HYD-1 and other references, create a map of high hydrologic impact areas on National Forest lands that are a priority for treatment. Those areas that result in a high potential for sediment delivery to streams would receive primary consideration. Prioritize the areas needing treatment.

Create a map of sensitive stream reaches (Rosgen C and E) on National Forest lands to highlight areas where streambank stability is of concern. These areas would be a focus for monitoring and, if deemed appropriate, changes in livestock management.

Create a map of stream segments lacking adequate shading to guide restoration **efforts and to focus monitoring of stream temperatures.** Emphasize those areas needing treatment.

Create a map of high road density areas on National Forest lands. Prioritize these areas for road obliterations and closures.

Classify ISAT data to determine current canopy closure levels for all ownerships. Determine assumed historic/sustainable canopy closures for all forest vegetation types. Develop an ECA-Canopy Closure relationship for all forest vegetation types (can be grouped where appropriate). Recalculate ECA levels based on ISAT-based canopy closure data. Interpret current ECA levels in light of historic and sustainable canopy closures and current stream and **watershed conditions.**

Obtain more recent and complete stream flow information for the SFS using the Day Use Area site. Develop a stage-discharge relationship for this site. Develop discharge relationships for subsheds within the SFS by taking paired flow measurements (or through other appropriate means).

Continue to inventory levels of detrimental soil conditions and include this information as part of each Specialist's Report. Feed this information into GIS for future use. Relate detrimental soil conditions to road densities, ECA levels and stream channel/riparian area conditions when assessing cumulative impacts.

Determine the relationships between season of use for grazing and effects on riparian area resources. Determine if earlier turnout dates, along with earlier removal dates for cattle, is a preferable alternative.

Install three-way exclosures in order to: 1) Correlate soil and hydrologic factors with biologic parameters that are impacted by management activities. 2) Determine long term relationships with various management techniques, vegetation, and physical parameters.

Determine the feasibility of brook/brown trout removal/eradication.

Determine the feasibility of barrier construction on Brownsworth and Camp Creeks.

Investigate biology of stream resident bull trout; including movements, population dynamics, temperature and sediment tolerances.

Collect genetic information on redband trout throughout the SFS and tributaries to determine if hybridization with stocked rainbow trout has occurred.

Investigate fine sediment sources throughout SFS and identify restoration measures.

Surveys of SFS intermittent tributaries for road crossing barrriers as well as road sedimentation problem identification is necessary.

Complete landscape pattern analysis as outlined in the Ecosystem Assessment Guide. The use of ISAT data to determine present seral stages and species composition needs to be emphasized. Groupings of attributes into classes (such as late seral) needs to be done for the watershed. Stand exam information needs to updated prior to the completion of any project level prescription for vegetation management.

APPENDIX

REFERENCES

VII. APPENDICES

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CORE TEAM

CORE TEAM MEMBERS

Nancy Rose - Bly R.D. District Ranger
BS-Forestry Management, 18 years experience.
Dave Schmitt - Core Team Leader
BS-Range/Forest Management, 22 years experience.
Dave Wenzel - Soil Scientist
BS-Soils Science, 28 years experience.
Terry Hershey - Wildlife Biologist
BS-Wildlife Biology, MS-Wildlife Management, 17 years experience
Bob Petersen - Acting Forest Silviculturist
BS-Forest Management, MS-Range/Ecology, 25 years experience.
Kristin Bail - Bly R.D. Resource Assistant-Hydrologist
BS-Geology, 10 years experience.
Tim Charnon - Bly R.D. Environmental Coordinator
BS-English/American Culture, MS-Forest Science, 4 years experience
Bob Nichols - Fisheries Biologist
BS-Environmental Science, 6 years experience.
Jim Rosetti - Writer/Editor
BS-Forest Management, 25 years experience.

KEY CONTACTS

KEY CONTACTS

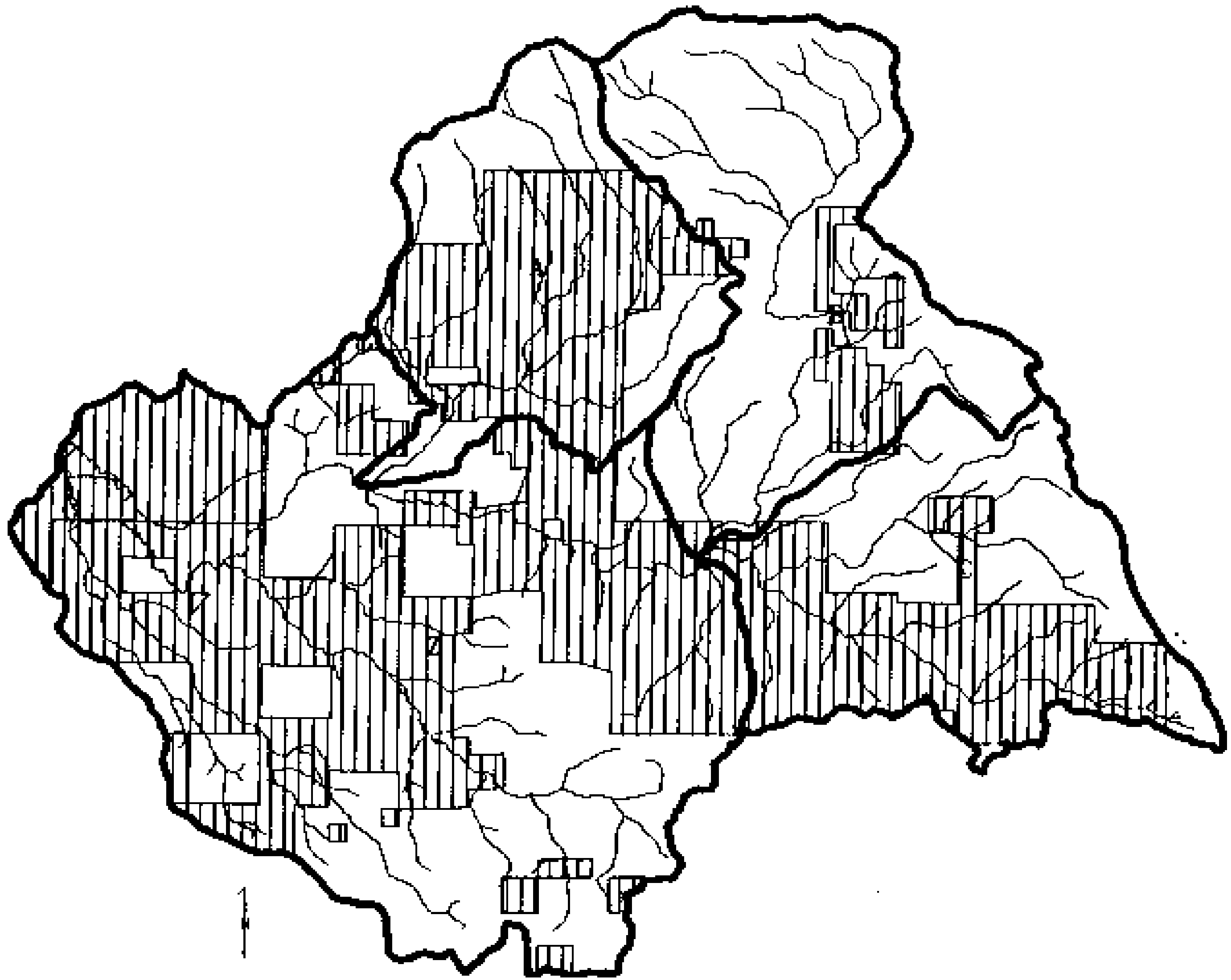
Ted Clegg - Private Landowner
Ned Livingston - Private Landowner
Arthur Banta - Private Landowner
Kevin Newman - Private Landowner
Wayne Baio - Private Landowner
Mark Caffney - Private Landowner
Dave Naslund - Private Landowner
Flora C. Haris - Private Citizen

R.W. Mezger - Klamath/Lake Forest Health Partnership
A.K. Majors - State of Oregon Wendell Wood - Oregon Natural Resources Council Barron Bail - Bureau of Land Management Curt Mullis -Ecosystem Recovery Office Lake County Commissioners - Public Officials Klamath County Commissioners - Public Officials Marvin Garcia - Klamath Tribe Klamath/Lake Forest Health Partnership - John Monfore - Weyerhaeuser Company Willie Riggs - Lake County Extension Agent

Rodney Todd - Klamath County Extension Agent
Glenn Barrett - Klamath Cattleman's Association
Beth Waterbury - Oregon Department Fish & Wildlife
Roger Smith - Oregon Department Fish & Wildlife
Larry Conn - Oregon Department Fish & Wildlife
Shelly Tucker - Soil Conservation Service (NRCS)
Bruce Hammon - Department of Environmental Quality

MAPS and DATA

WQ-1 SO. FORK SPRAGUE SUBSHEDS/STREAMS



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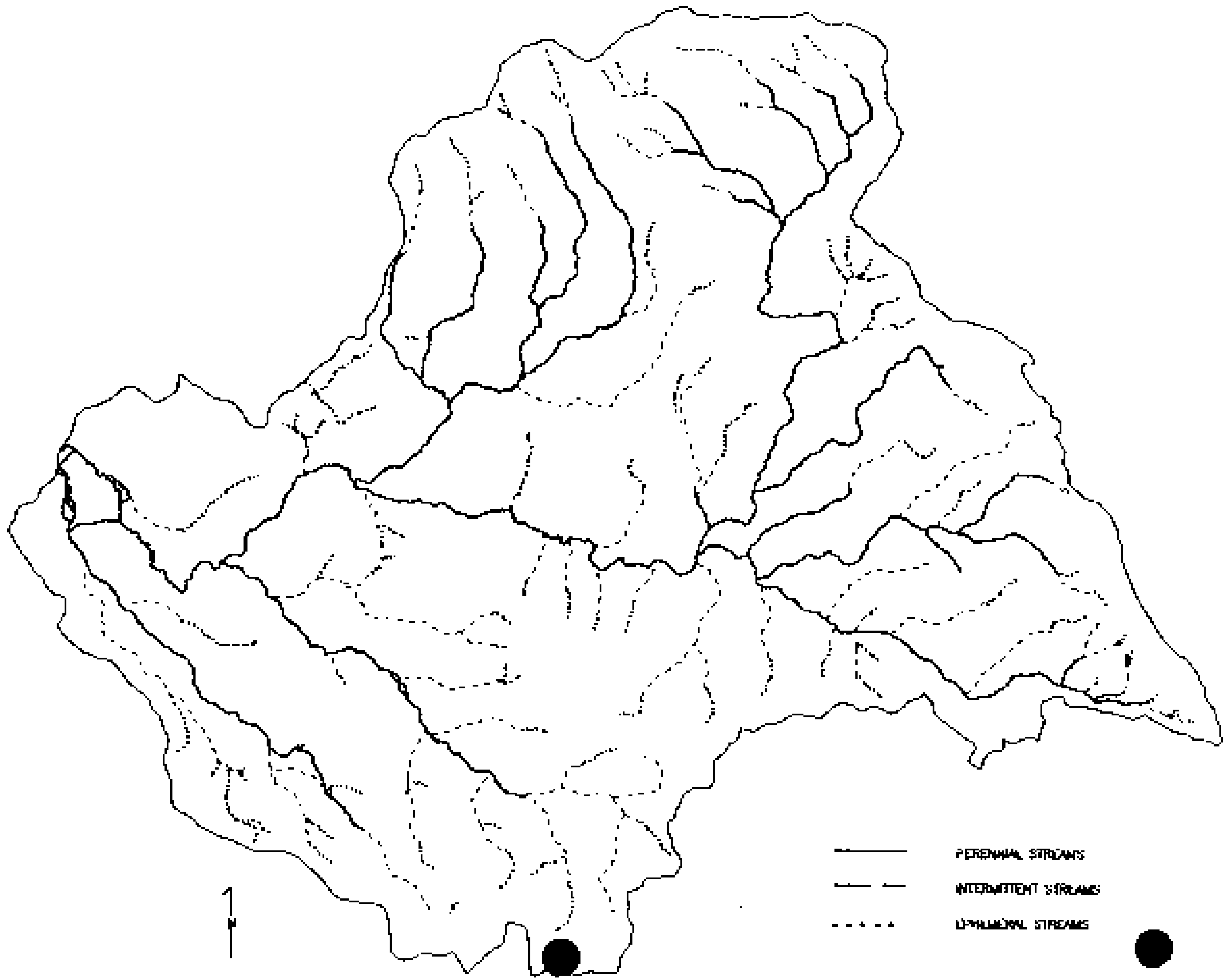
WQ-2

SO. FORK SPRAGUE STREAMS



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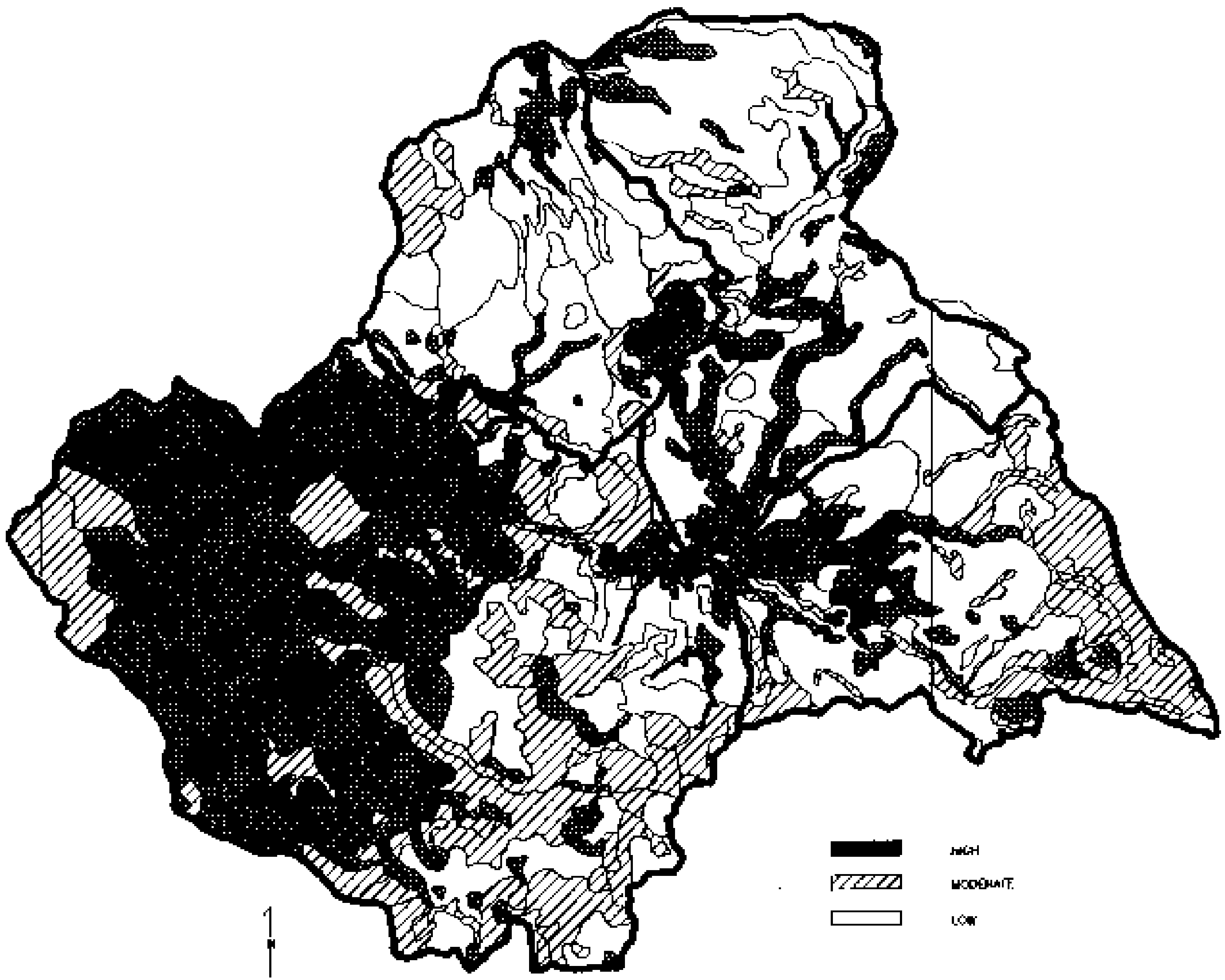

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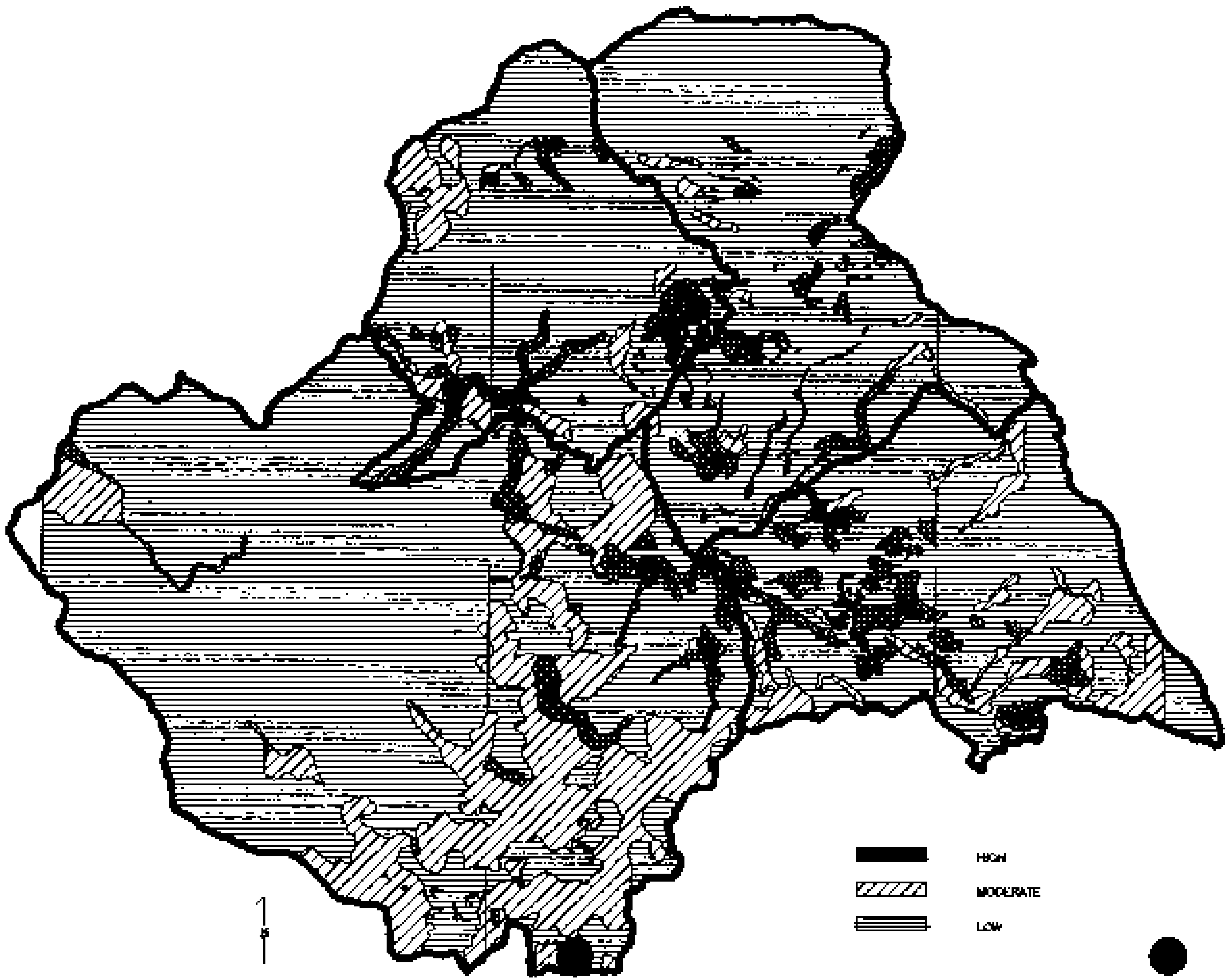
SO. FORK RISK OF SHEET EROSION



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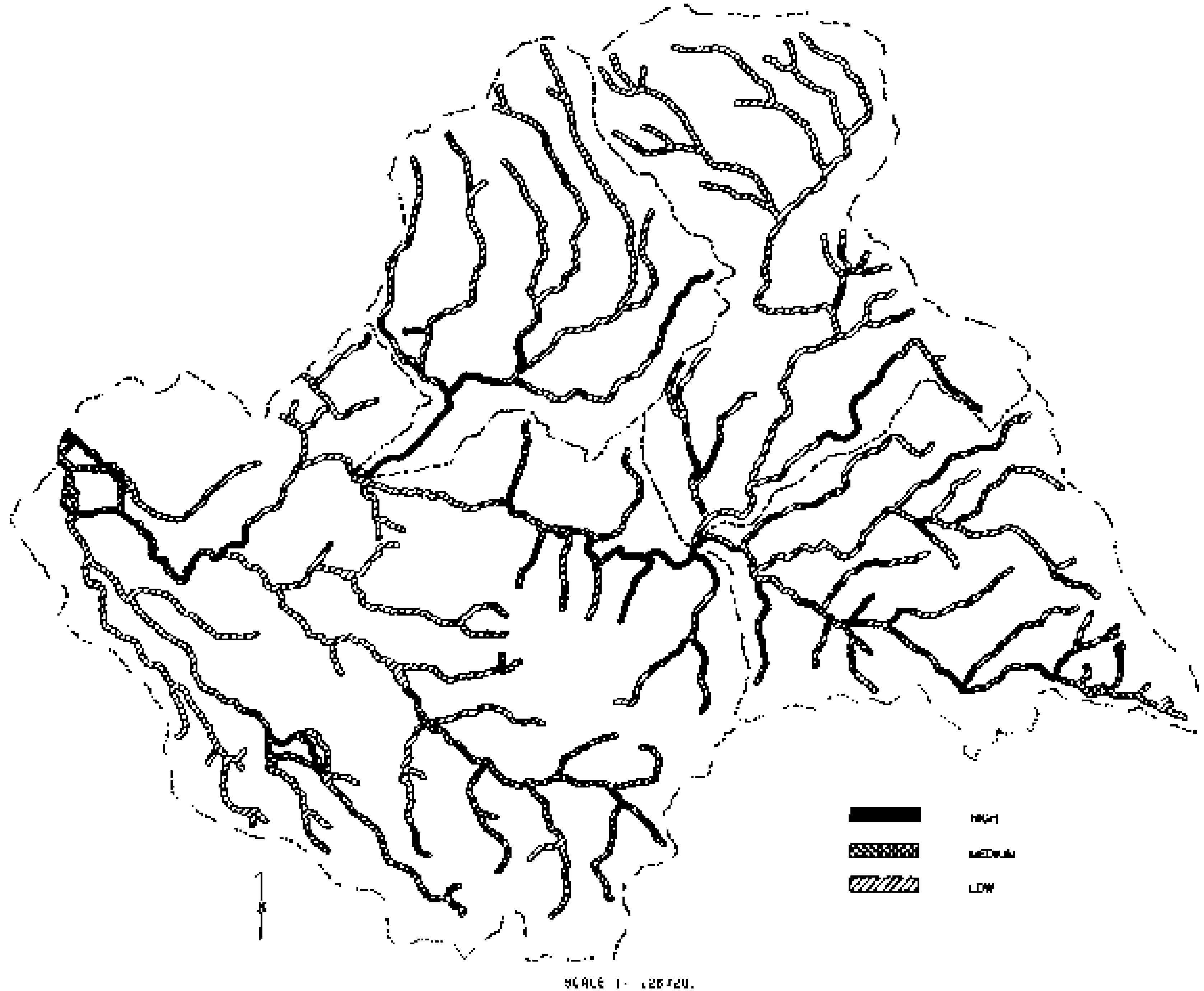
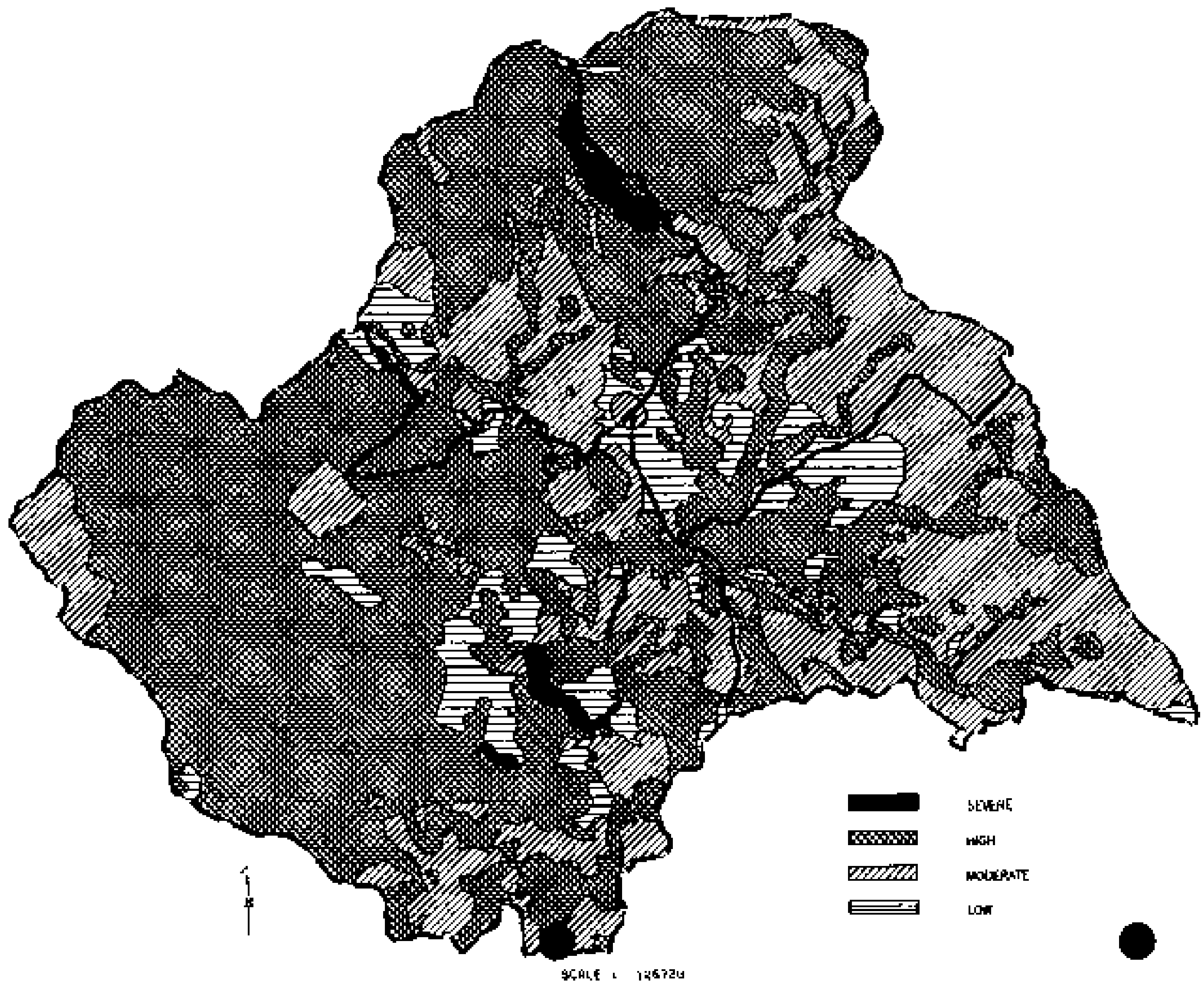
SO. FORK DELIVERY POTENTIAL



WQ-6

SO. FORK GULLY EROSION POTENTIAL



WQ-7

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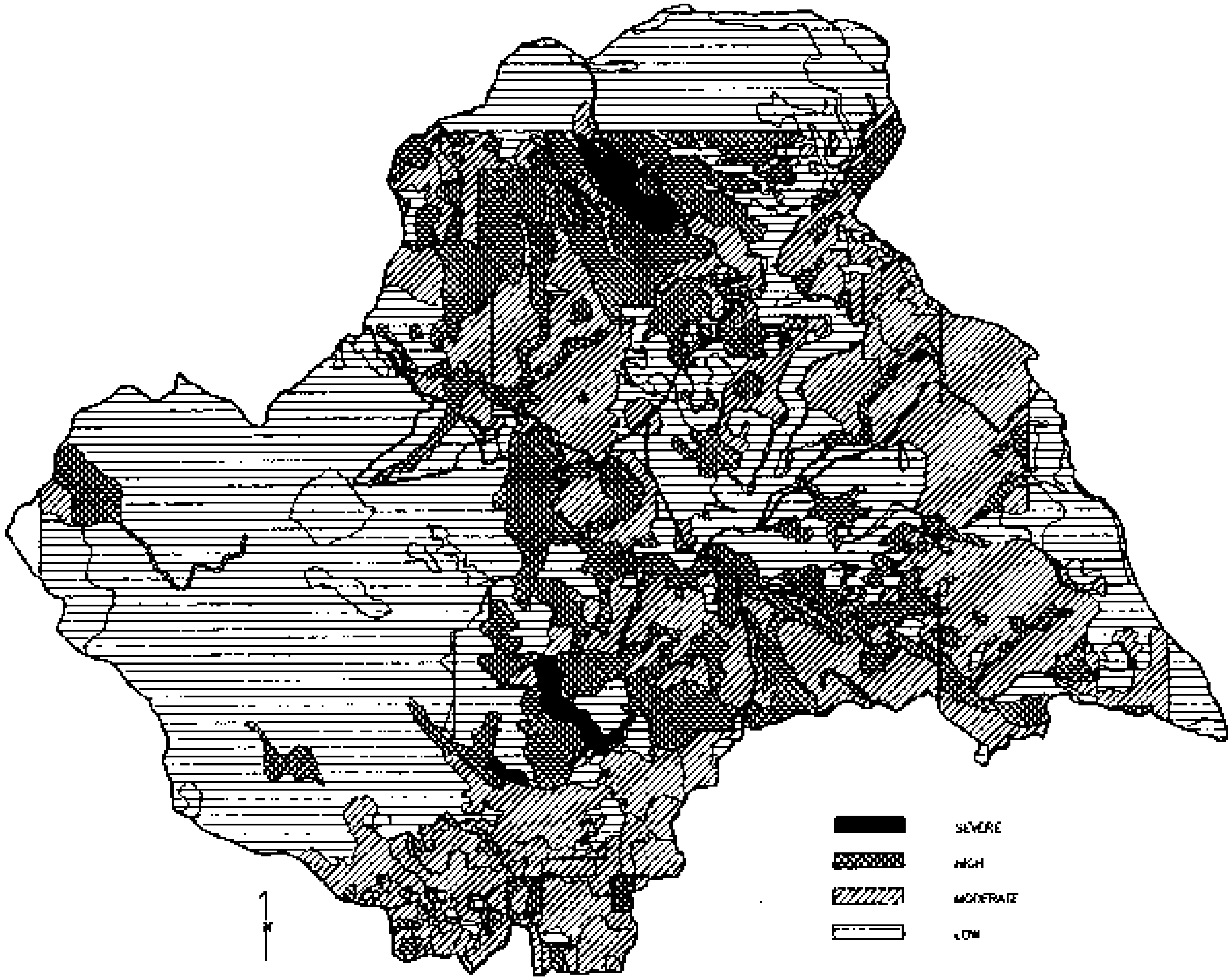

WQ8

SO. FORK ROADS

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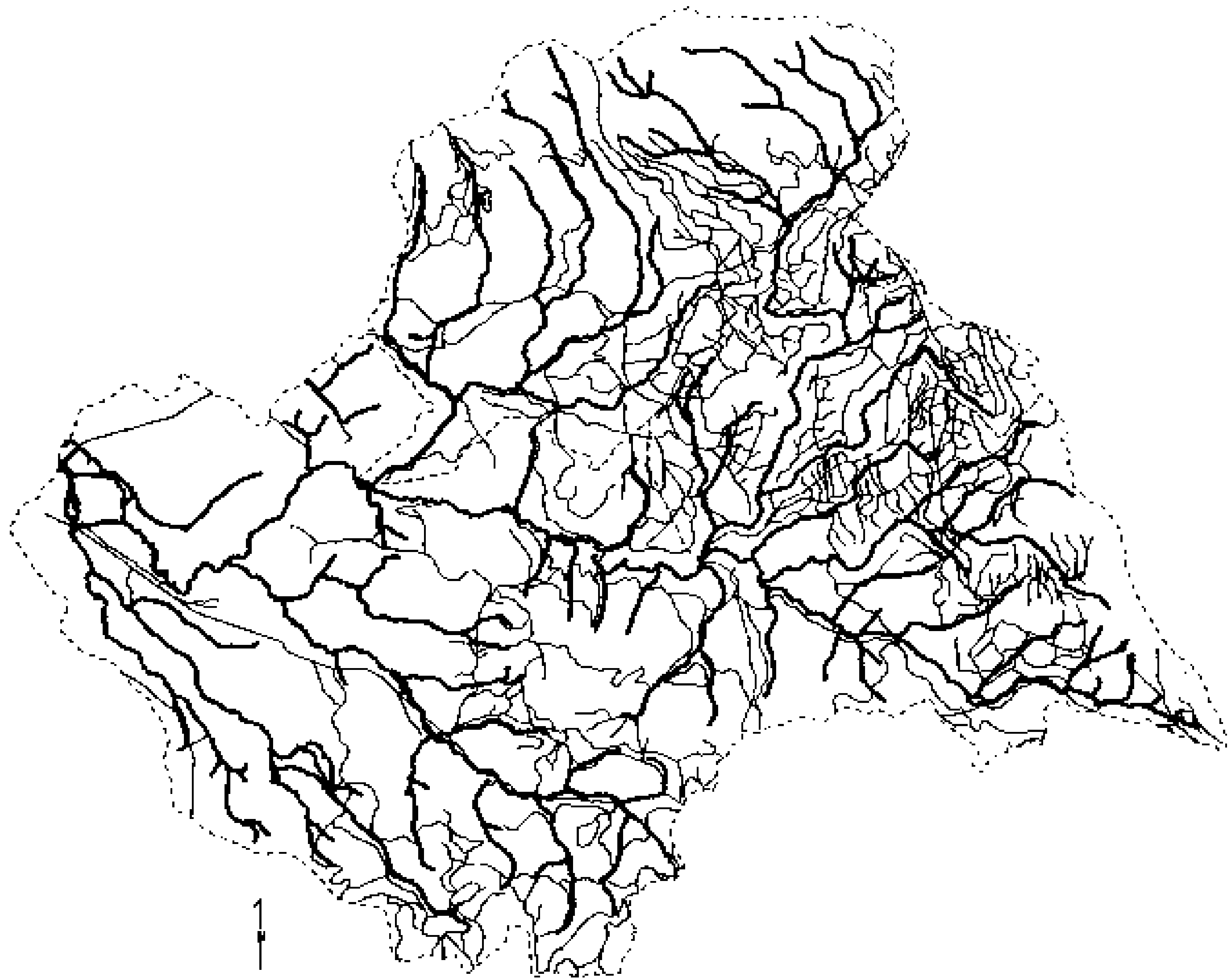
MAP 009

SO. FORK ROADS CROSSING STREAMS



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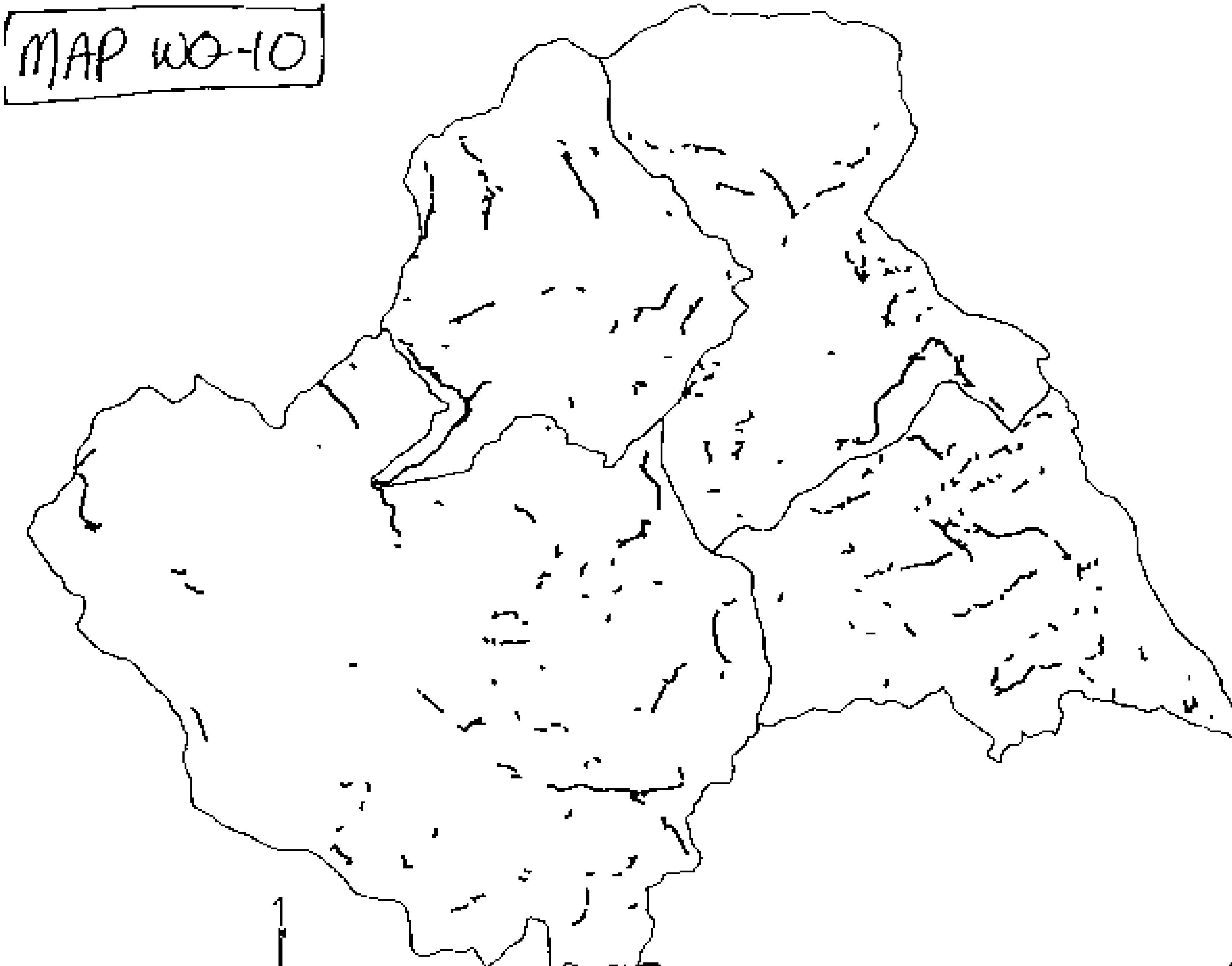
SO. FORK ROADS W/IN 200' OF STREAMS

MAP WQ-10



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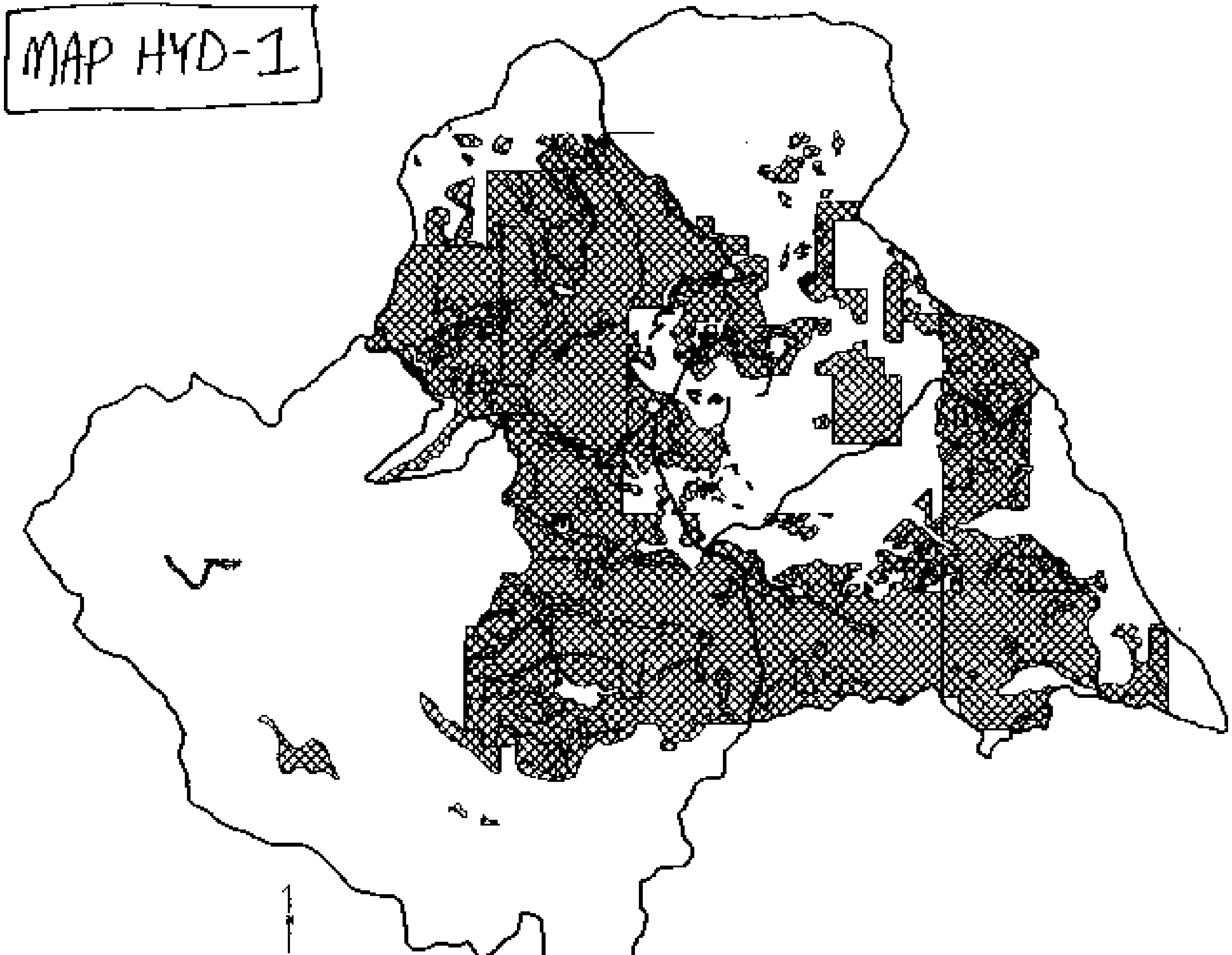
SO. FORK HIGH HYDRO IMPACT AREAS

MAP HYD-1



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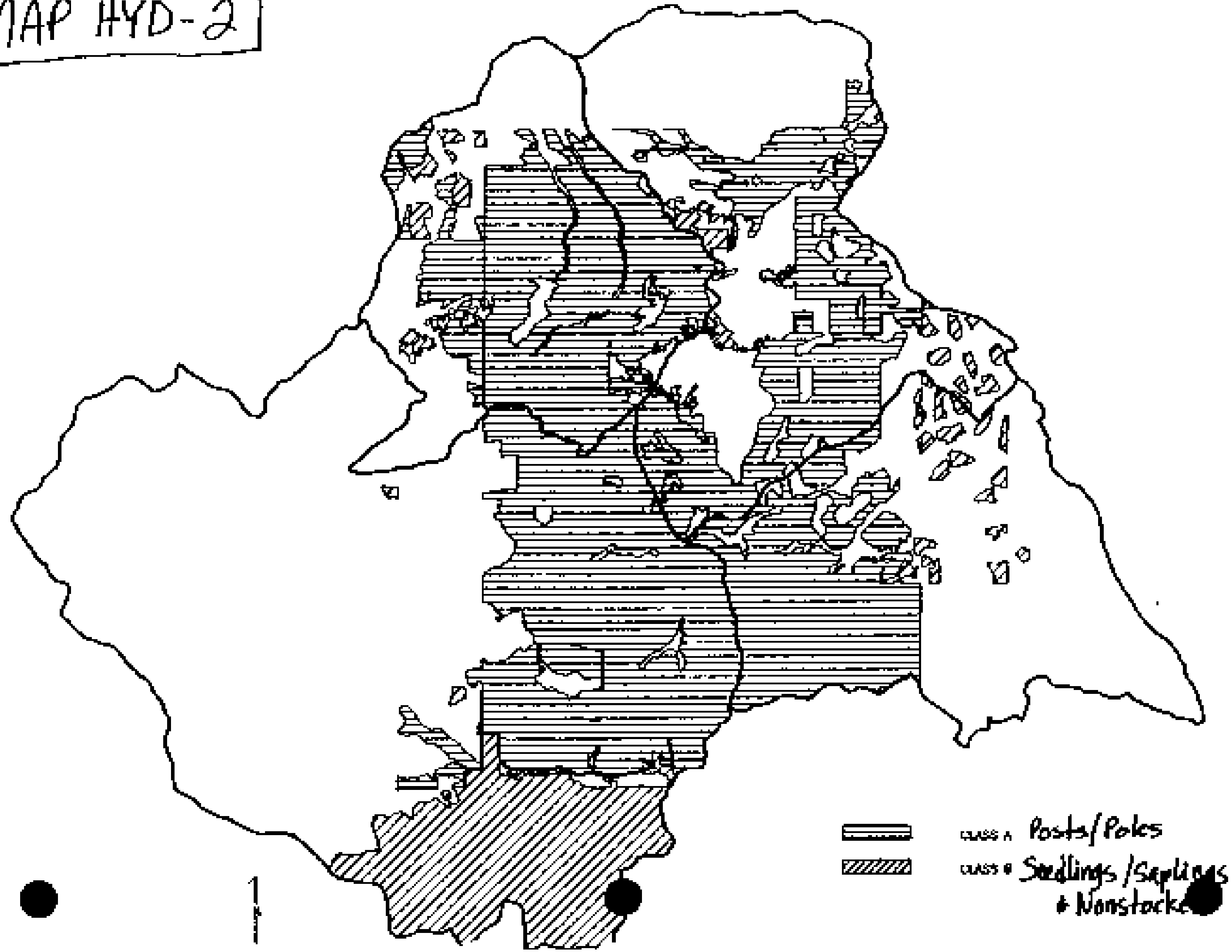
SO. FORK CURRENT CLEAR CUT EQUIVALENT

MAP HYD-2



South Fork of the Sprague River Watershed

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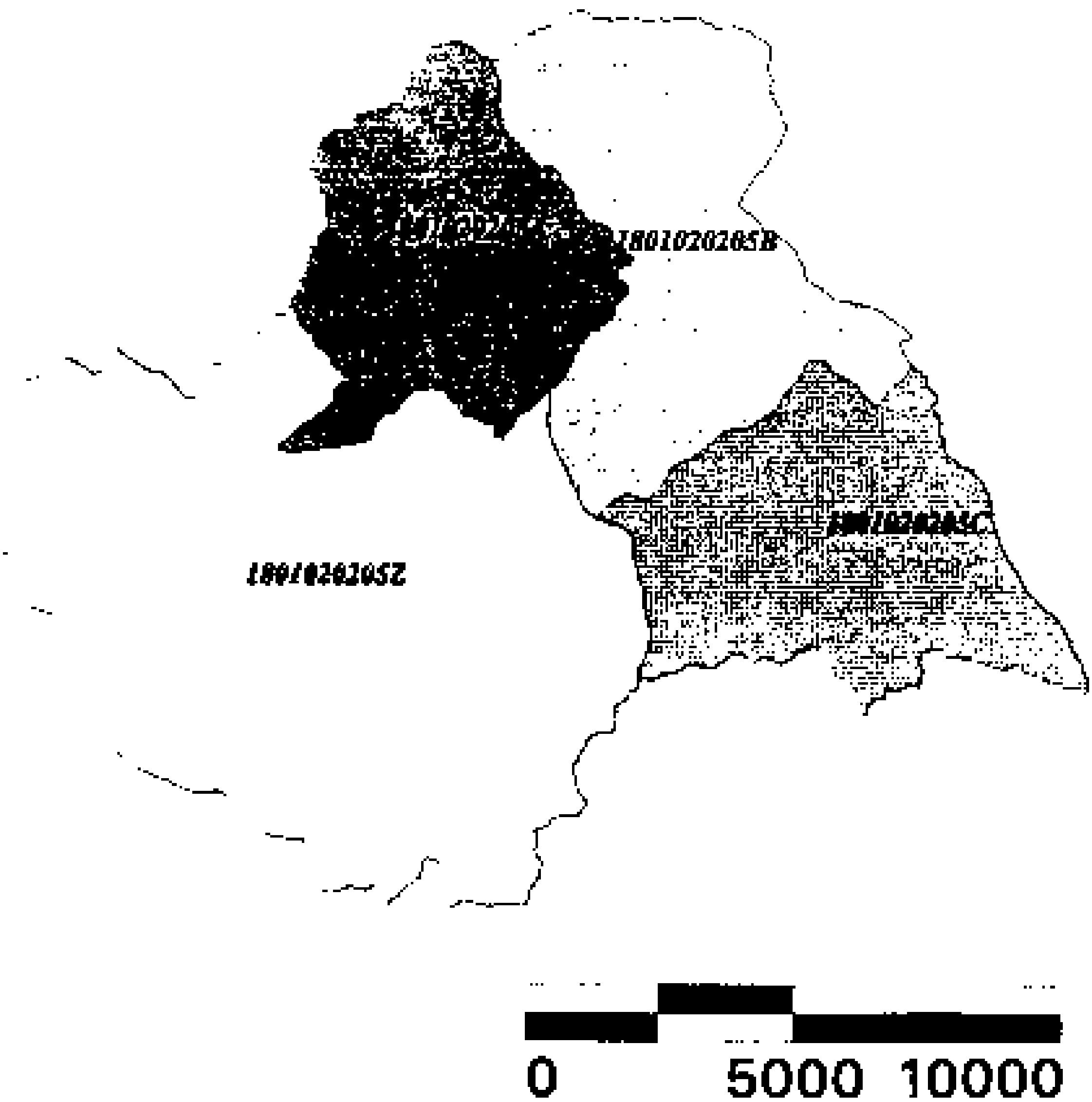
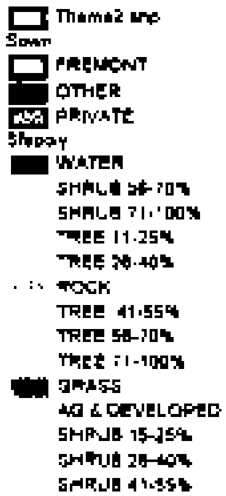
- 1801020205B
- 1801020205C
- 1801020205Z

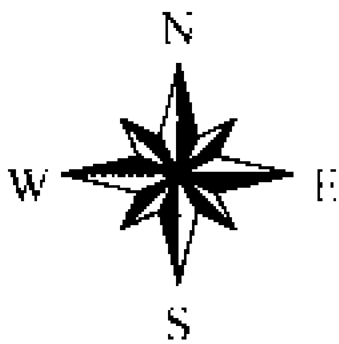
Sfswshd



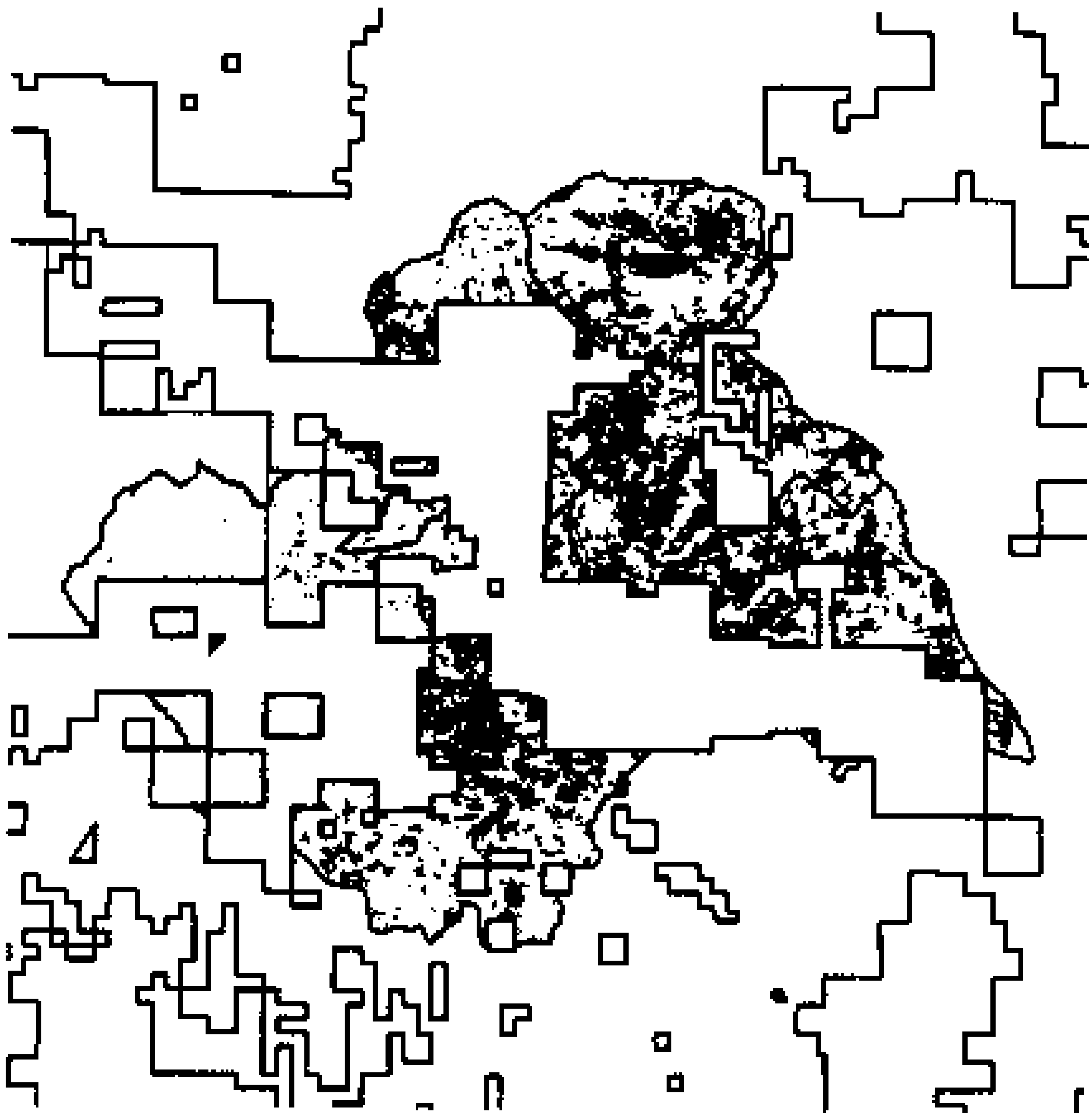
South Fork of the Sprague River



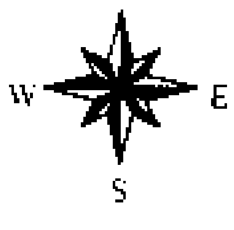
Canopy Closure



South Fork of the Sprague River

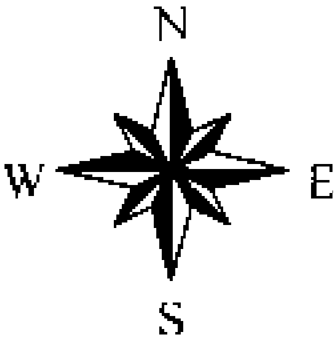


Non-Forest, Range, and Understory

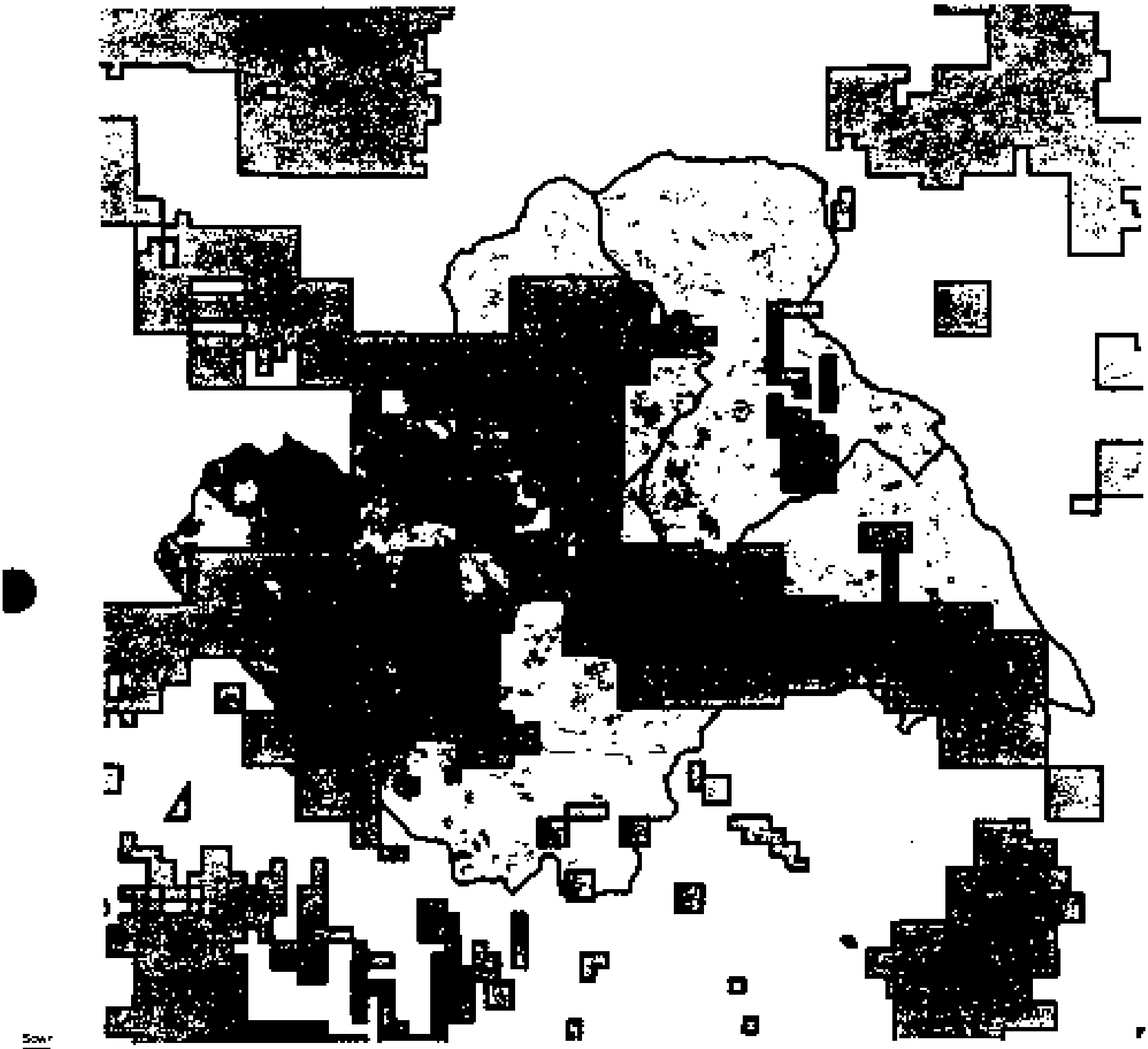


So. Fork of the Sprague River

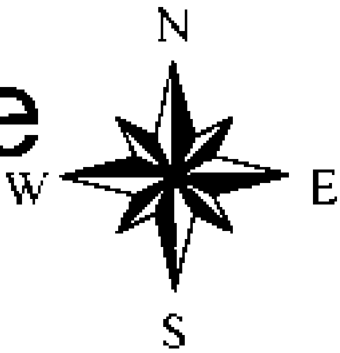
Forest Species Groups



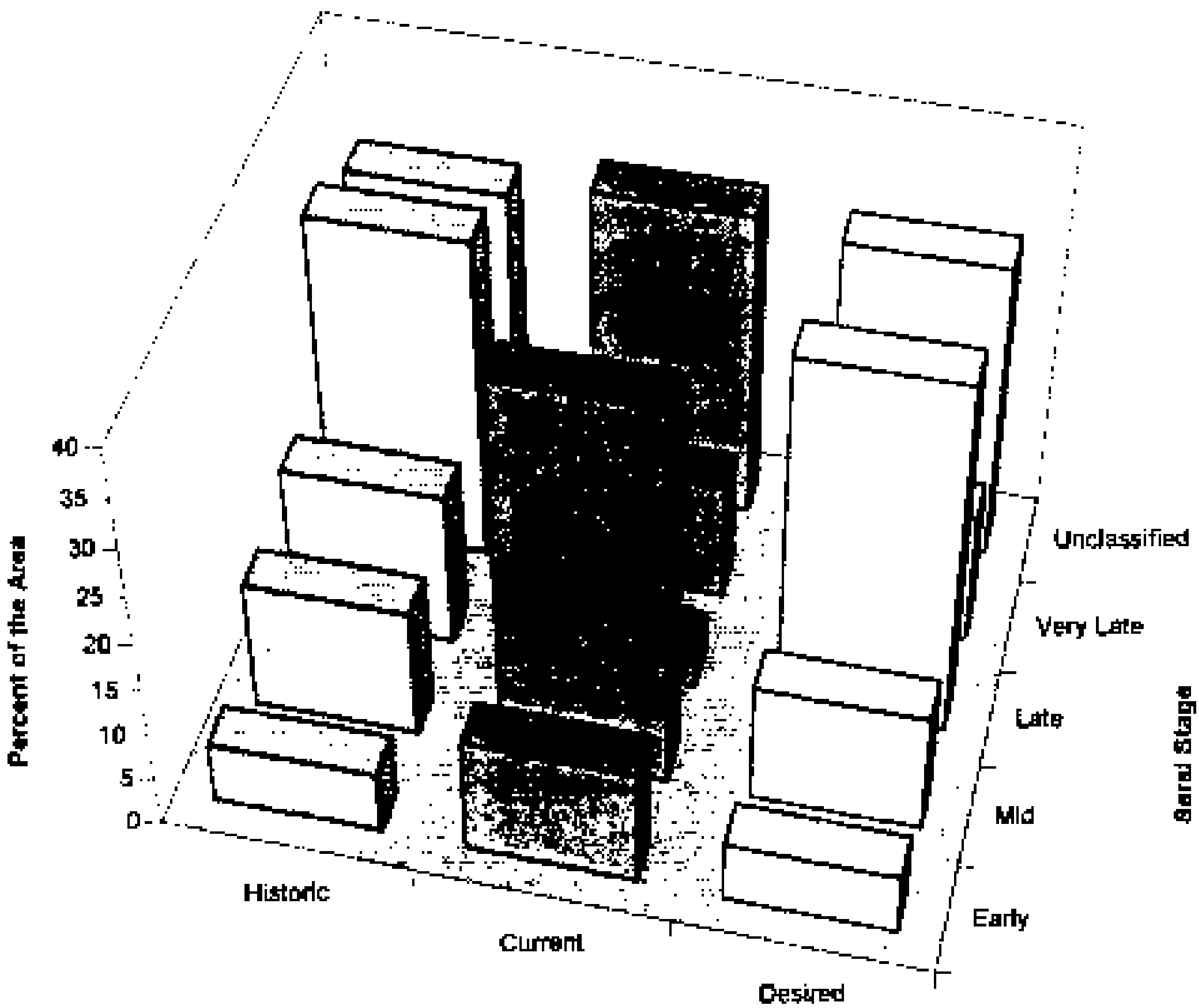
South Fork of the Sprague River



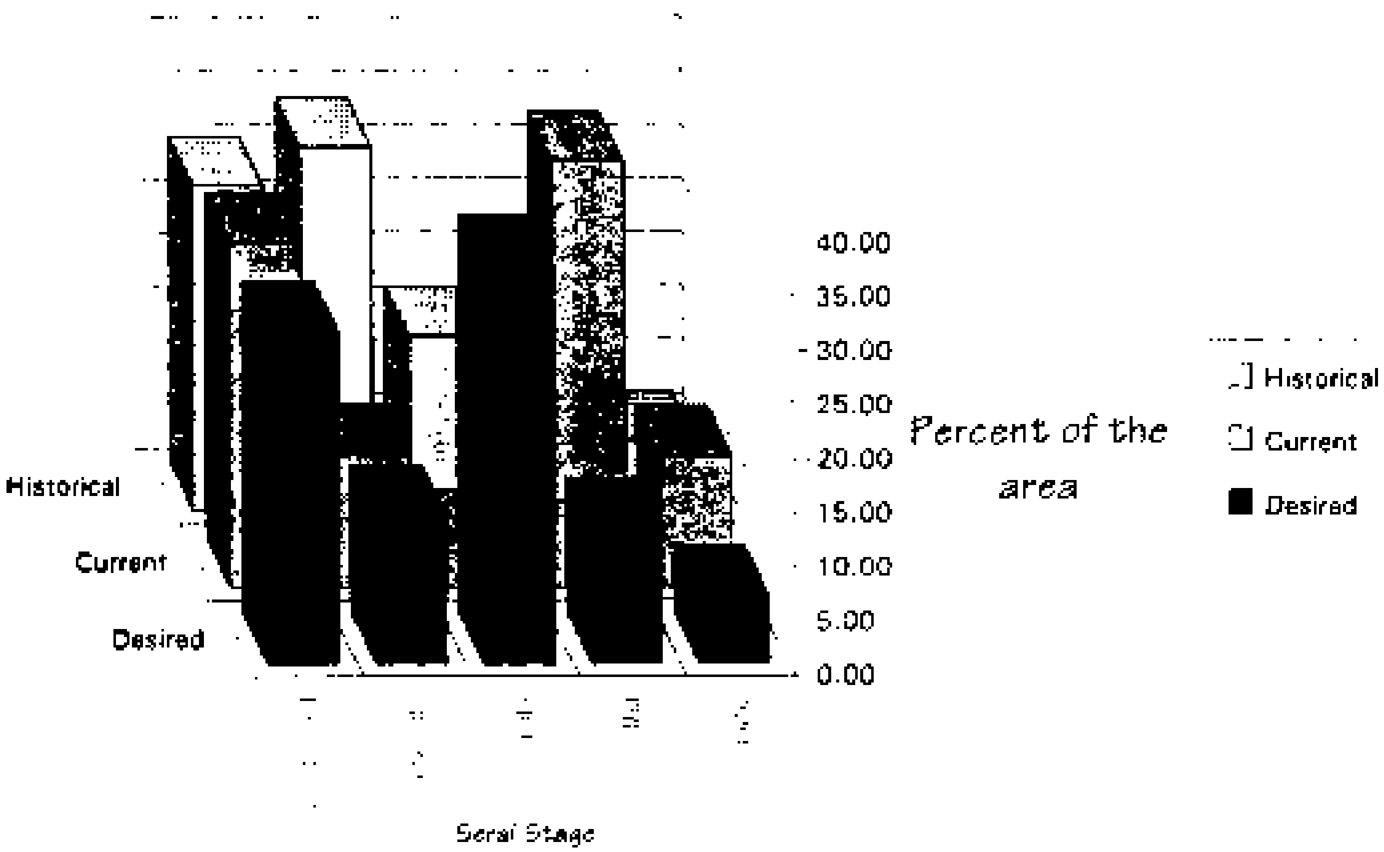
Size Structure



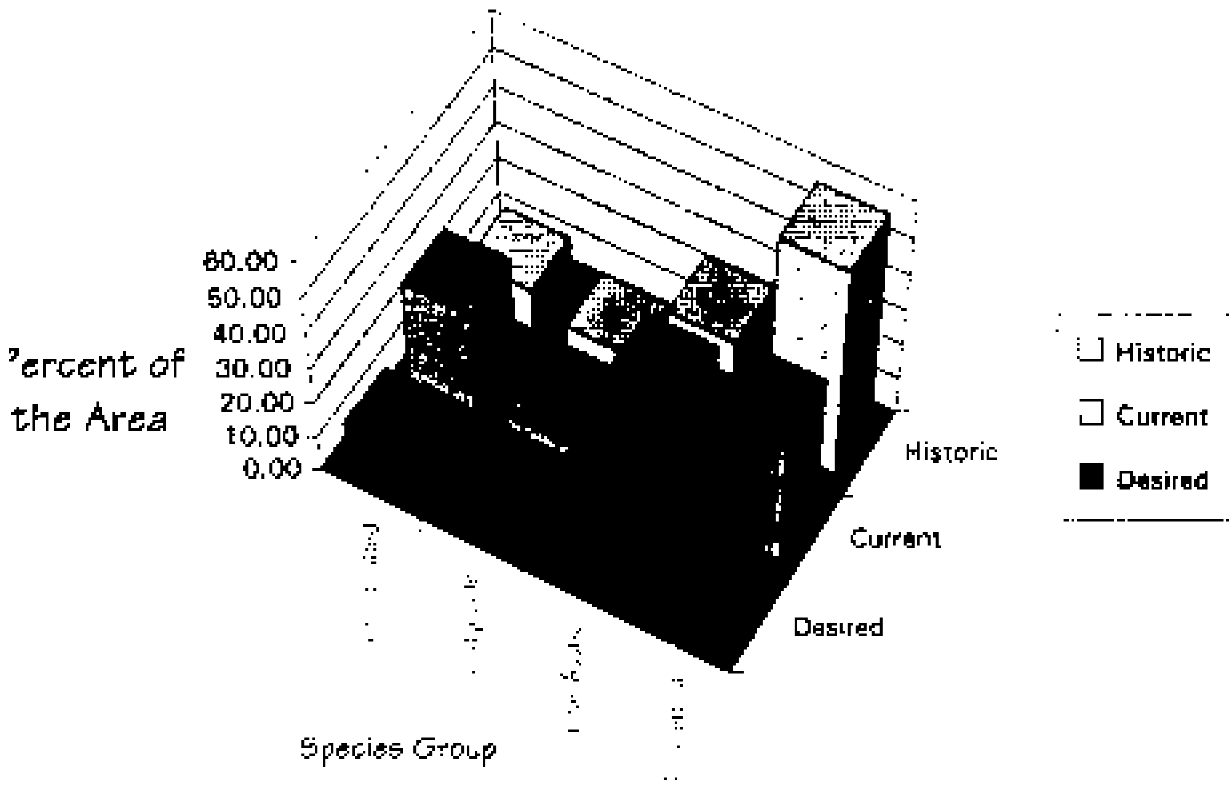
Seral Stage

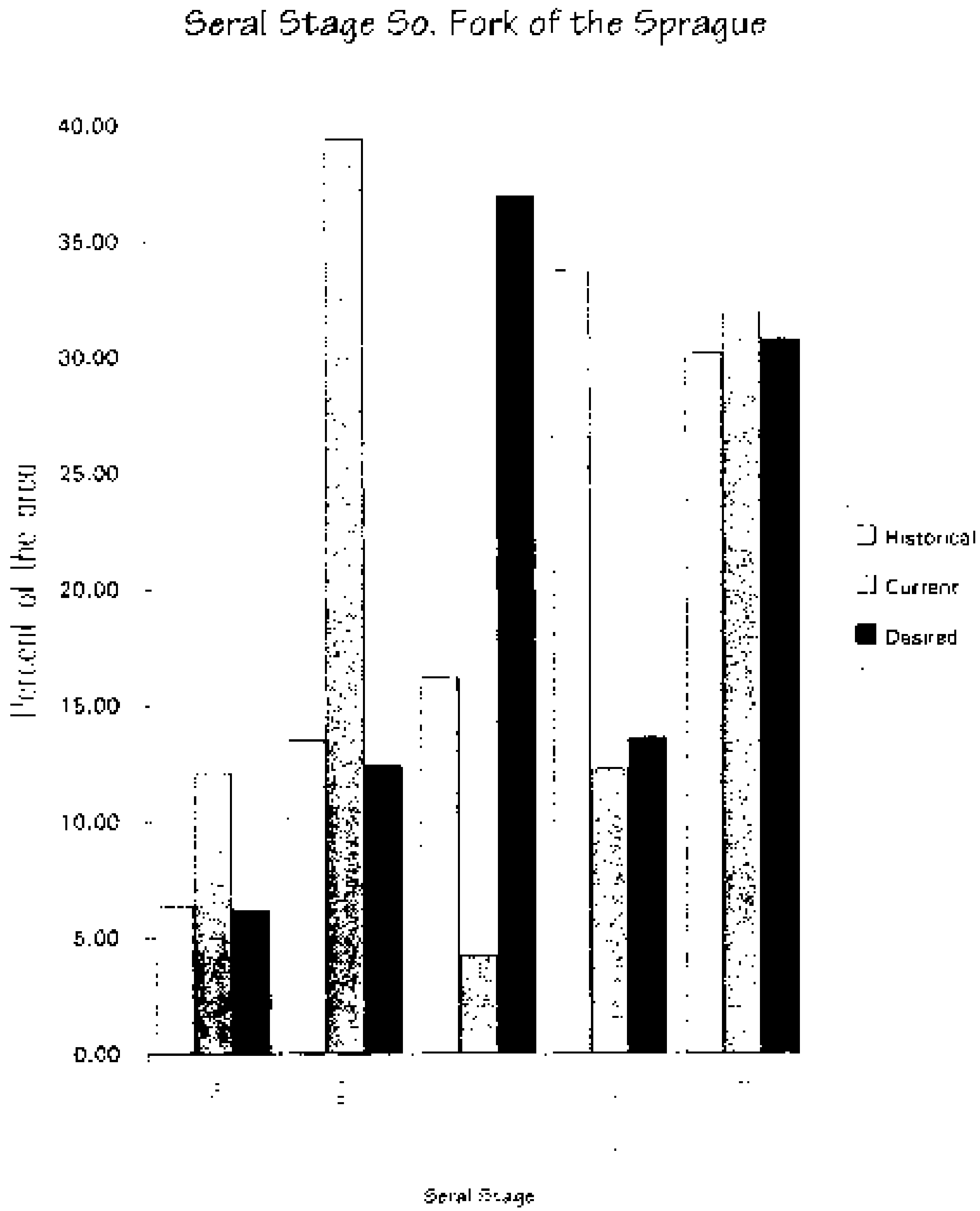

40
35
30
25
20
15
10
5
0
Percent of the Area
Historic
Current
Desired
Unclassified
Very Late
Late
Mid
Early
Seral Stage

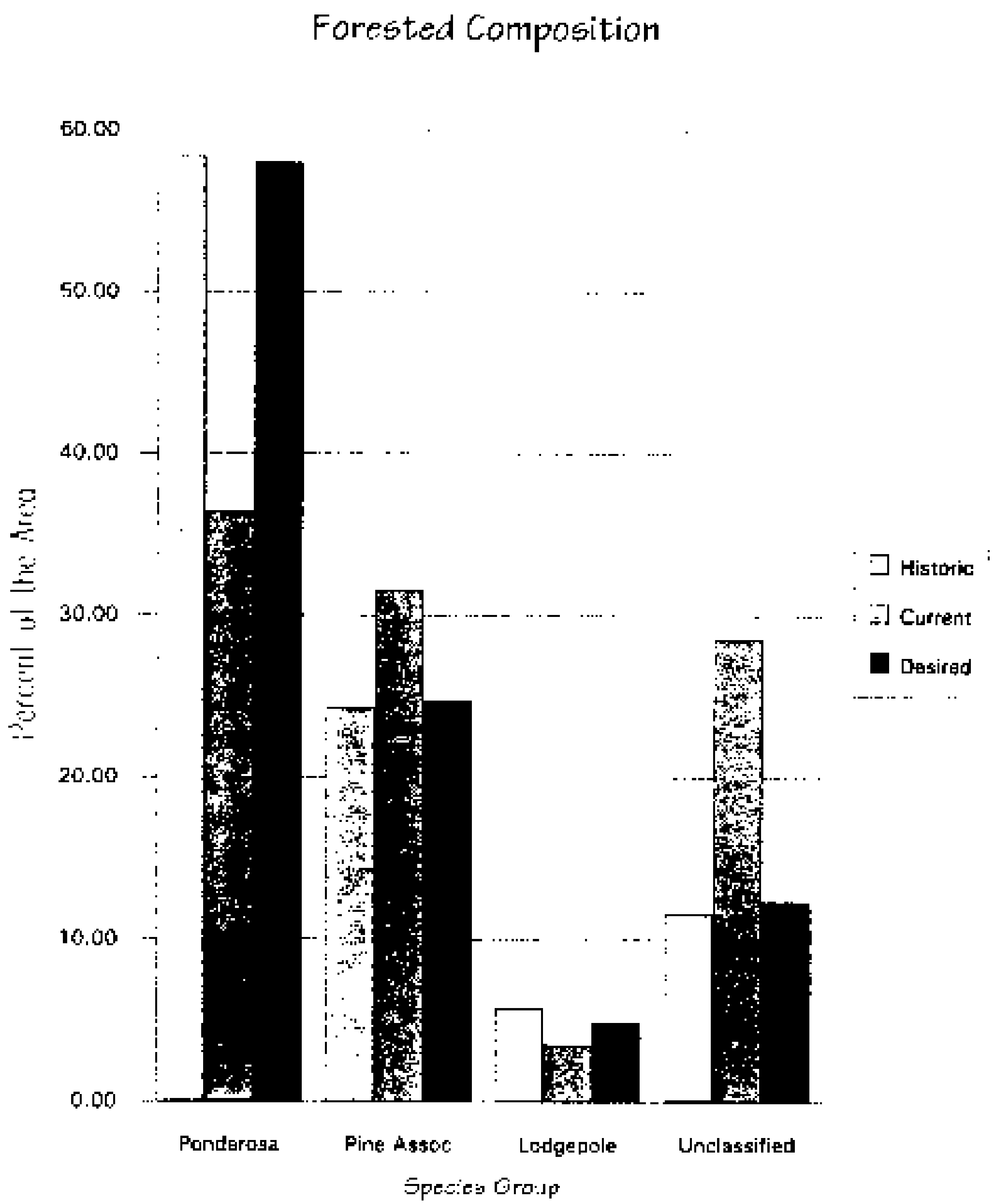
Seral Stage So. Fork of the Sprague



Forested Composition




Seral Stage So. Fork of the Sprague
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Percent of the area
Historical
Current
Desired
Seral Stage


Forested Composition
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Percent of the Area
Historic
Current
Desired
Ponderosa
Pine Assoc
Lodgepole
Unclassified
Species Group

Appendix WATER-1
Water Resources and Basic Hydrologic Principles

Introduction

This appendix describes many of the principles and procedures used in the management of water resources in the South Fork Sprague River watershed. The analysis contained in this appendix is meant to supplement what is contained in the Analysis section of this document.

Water Quantity

Oregon's latitude, topography, and location near the Pacific Ocean have a great influence upon its climate. The Coast and Cascade ranges play a major role in determining precipitation type and distribution. The prevailing air masses that move across Klamath and Lake counties from the Pacific Ocean have been greatly modified as a result of their passage over the Cascade Range. Continental air masses that move down from the interior of western Canada are also a major weather factor.

Precipitation is an important climatic variable that influences the productivity and management of resource lands. Estimates of precipitation are used for planning numerous forest management activities, such as the location, design, and maintenance of roads, and the selection and scheduling of harvesting and reforestation systems.

Interception occurs when rain or snow lands on vegetation rather than the ground. Some of this intercepted water evaporates and the remainder falls to the ground. Water also evaporates from the surface of water bodies and soil. Under forested conditions, evaporation from soil surfaces is minimal. Evapotranspiration is the process in which water is taken up by plants and then evaporates into the atmosphere.

Infiltration is the movement of water into the soil surface. Surface runoff is the distribution of water after it precipitates on the land until it reaches stream channels, or penetrates the ground, or returns directly to the atmosphere through evapotranspiration. For example, when the rainfall rate exceeds the infiltration rate, water will travel over the ground surface, as surface runoff, to a channel. Generally, surface runoff can be quantified as the precipitation amount minus surface retention, infiltration and evapotranspiration amounts. Infiltration rates in forest soils of south central Oregon usually exceed the maximum rates of rainfall, thus allowing most of the water that reaches the earth's surface to enter the soil.

Soil compaction can significantly change the hydrology of a watershed by reducing infiltration rates. Infiltration rates are reduced by soil disturbance and compaction associated with timber harvest activities when roads, tractor skid trails, and landings are built to remove timber. Compaction can also be caused by site preparation following timber harvest. Other changes in hydrology occur from the routing of runoff through culverts and ditches which causes rapid delivery of water to stream channels, possibly increasing the size of peak flows. Increases in peak flows appear to be related to the amount of soil compaction in a watershed, and can cause increased channel degradation and downstream sedimentation.

Soil compaction, and vegetation or ground cover removal can cause increases in surface runoff, which can affect the amount and timing of peak flows.

Interception losses can be reduced, thus allowing more precipitation to reach the soil surface. The manipulation or removal of vegetation can affect the accumulation and melting of snow. The level of influence is related to the type of vegetation treatment and the various climatic and physiographic conditions influencing the site. Wildfire, prescribed burning, site preparation (such as scarification) and grazing can reduce ground cover (live vegetation and litter) and, in turn, increase surface runoff. It *is* important to retain ground cover because vegetation and plant litter keep flowing water spread out over the surface of the land and mechanically retards or hinders runoff, so that water moves more slowly and more opportunity is allowed for infiltration or uptake by vegetation.

Livestock grazing affects watershed properties by alteration of plant cover and by soil compaction from the physical action of animal hooves. Reductions in vegetation cover may in turn increase the impact of raindrops, decrease soil organic matter and soil aggregates, increase surface crusts, and decrease water infiltration rates. These effects may cause increased runoff, reduced soil water content, and increased erosion. The hydrologic impacts of grazing intensity are related primarily to infiltration and runoff. Increased runoff can increase upland sheet and rill erosion, resulting in stream sedimentation. Increased peak runoff can also increase stream energy for bank erosion, downcutting, and gully formation. Reductions in water infiltration and storage can reduce the magnitude and duration of low flows. Grazing can remove protective ground cover and disturbs litter and soil, while trampling by grazing animals can compact surface soils. The amount and timing of peak flows from runoff is thought to be positively correlated with the intensity of grazing within a drainage. Adverse impacts to riparian vegetation from grazing can negatively affect the hydrology of a stream because riparian-wetland areas contribute to groundwater recharge and maintenance of flows.

Streamflow

The amount of water draining from a given area in a year *is* referred to as the annual water yield and is usually expressed in acre-feet (1 acre-foot equals 43,560 cubic feet) or the average depth over an area in inches. The annual yield of an area can be converted to the average annual flow (in cubic feet per second) of the stream draining the area.

Streamflow is the water that reaches the stream channel. Total streamflow is a product of all the other processes in the hydrologic cycle. Distribution of annual streamflow in south central Oregon is related to the distribution and type of annual precipitation; thus, in the watershed area high flows are observed during the spring and low flows are predominant from July through October. Below normal precipitation in the watershed area from 1985 through 1992 and in 1994 has contributed to extremes in summer low flows. Naturally low summer flows, when combined with withdrawals for irrigation or other consumptive uses, can have a serious impact on other beneficial *uses.*

Timber management activities, such as road construction, harvest, and slash disposal, affect streamflow because they remove forest vegetation. Removal of forest vegetation reduces the amount of precipitation that returns to the atmosphere from interception and transpiration. More precipitation reaches the soil surface and drains into streams or becomes groundwater. Increases in streamflow can cause more frequent flooding, leading to decreased stream bank stability and increased movement of sediments.

The amount of streamflow increase resulting from removal of forest vegetation is proportional to the type of harvest, the area harvested within a specific watershed, and the time since harvest. Streamflow increases are most noticeable in small watersheds that have large areas of vegetation removed over a short time period. Streamflow increases in large basins tend to be masked, because the nonvegetated area is small relative to the size of the basin.

Increases in streamflow due to vegetation removal are not distributed evenly throughout the year. Summer streamflow increases result from greatly reduced transpiration which allows more water to drain through the soil to the streams. Increases in summer flows appear large when compared to the naturally low levels during the summer months. Summer increases are relatively short-lived because of the growth of vegetation along stream channels. Seasonal changes in streamflow following timber harvest are also linked to seasonal differences in soil water content between forested and harvested areas.

The duration of increased streamflow after removal of vegetation is not easily predicted; however, Harr (1983a) found that 27 years can be required for streamflow increases to disappear. The return of vegetation results in annual streamflows decreasing to preharvest levels as both interception and transpiration increase. Evaporation from the soil surface is generally increased after timber harvest; however, this increase is offset by the reduction in transpiration.

The magnitude of peak flows can be increased by timber harvest in the transient snow zone, which is located at elevations where the snow level fluctuates in response to alternating warm and cold fronts. The transient snow zone in the watershed area is generally between 2,500 and 4,500 feet. Snow accumulation is greater in clearcut openings than in undisturbed forests. Rain-on-snow events can result in rapid melting of the snowpacks in clearcut areas, resulting in more snowmelt being generated from clearcut openings and larger peak flows. However, timber removal is limited in its effect on the size of large peak flows, which cause extensive downstream flooding during heavy precipitation. When large peak flows (floods) occur during such heavy precipitation, the difference in soil moisture content between forested and harvested areas can become insignificant, and the hydrologic behavior of each area can become nearly identical. Soil disturbance can have an influence on the frequency and magnitude of small and large peak flows. The degree of influence depends upon the amount of area compacted by roads and tractor skid roads, and the proximity of the compacted area to stream channels.

Water Quality

Sediment, stream temperature, turbidity, dissolved oxygen, and chemical composition are important water quality components that indicate the level of protection of the beneficial uses within a watershed. The state's water quality requirements pertaining to National Forest management practices in the watershed area are the requirement for the highest and best practicable control of waste activities [Oregon Administrative Rules 340-41-965(1)], water temperature (Oregon Administrative Rules 340-41-965(2)(b)], turbidity (Oregon Administrative Rules 340-41-965(2)(c)], coliform [Oregon Administrative Rules 340-41-965(e)], and the antidegradation policy (Oregon Administrative Rules 340-41-026). The Oregon Department of Environmental Quality is reviewing and proposing changes to its water quality requirements, of which several (the antidegradation policy, dissolved oxygen, temperature, coliform, and turbidity) relate to National Forest land management practices.

Streams flowing from undisturbed forests generally have excellent quality. This characteristic makes streams valuable for domestic water supply, fish production, and recreation. Natural processes such as surface erosion, landslides, and flood events can increase sediments in stream channels, causing a detrimental effect on water quality.

Units of Measurement. Most chemical parameters of interest, *as* well as most sediment data, are reported in terms of concentrations, discharge, or yield. Water quality data is usually reported as concentrations or weight per unit volume, usually milligrams per liter or micrograms per liter. In generally high-quality waters, milligrams per liter equals parts per million, and micrograms per liter is equivalent to parts per billion. Sediment and chemical data can be expressed in terms of discharge (weight or volume per unit time, tons per day, or cubic feet per year) or yield (weight or volume per unit area of the watershed, such as tons per acre, acre-feet per square mile, or kilograms per hectare). Water temperature *is* measured in degrees Fahrenheit or degrees Celsius; turbidity is measured in Jackson or Nephelometric Turbidity Units; conductivity *is* measured in microsiemens, which are numerically the same as micromhos; and bacteria are measured in number of organisms per 100 milliliters.

Stream Temperature. Water temperature is one of the most important factors for survival of aquatic life. Most aquatic organisms are adapted to thrive within a limited range of temperatures. The primary concern with increases in water temperature is the potential for detrimental effects on fish and other aquatic organisms. Above-optimum water temperatures can be attributed to both natural and human-induced factors. Natural factors include low summer flows resulting from minimal to no precipitation during the summer, high summer air temperatures, wide channels, stream orientation, and geology.

Solar radiation is the main cause of increased water temperatures from management activities. Shade from riparian vegetation plays *a* major role in keeping streams cool. Stream temperatures may be affected if shading vegetation from stream banks is removed during timber harvest. Livestock grazing can cause water temperature increases by removal of stream-shading vegetation and the widening and shallowing of the stream channel by stream bank damage. These changes in the shape of the stream channel increase its surface area and its exposure to solar radiation. Because of its increased surface area, a wide, shallow stream will heat more rapidly than a deep, narrow stream. The color and composition of the streambed, the amount of water in a stream, the amount of sediments suspended in the water, and the direction that a stream flows all affect how fast and how much a stream may become heated. Because downstream shading does not significantly lower temperatures of streams warmed by upstream exposure, water temperatures of large streams also increase if small tributaries are exposed to solar radiation. The magnitude of this effect is dependent on the temperature and quantity of groundwater inflow, as well as inflow from other well-shaded tributaries.

Sediment and Turbidity. Sediment, or particulate matter, is described *as suspended* and settleable solids of organic and inorganic nature. Sediments occur naturally in water as products of weathering and erosion. Wind, water or frost action on rock surfaces result in the gradual breakdown of large, solid rock pieces into fine sand. Nutrients necessary to plant and animal life (iron, phosphorous, sodium, calcium) are transported as sediments, using rivers and streams as pipelines.

Erosion and sediment transport are natural processes that can improve as well as degrade streams and riparian areas within a watershed. Water erodes gravel banks to provide a continuing source of gravel for a stream, shifts gravel bars, and forms or deepens pools, all of which benefit spawning and rearing fish. However, erosion of fine-textured soils such *as* clays, silts, and fine sand can reduce habitat quality by filling in or smothering spawning gravels or by reducing water quality. This type of sediment can cause adverse effects when suspended in the water column or when deposited on the substrate. Some of the common measurements of sediment are turbidity, suspended sediment, settleable solids (wash load and bed load), and percent accumulated fine materials.

Suspended sediments are those carried in suspension. Rapidly flowing water can carry more suspended sediments than slow-moving water. As water flow slows, the largest particles settle to the bottom first. The lightest sediment particles are suspended the longest. Thus, clay particles, which are quite small, tend to stay suspended longer than sand particles. Suspended sediments can give water a murky or cloudy appearance by reducing light penetration. Suspended sediment clouds water and can cause fin and gill damage in adult fish. Deposition of suspended sediment in lower gradient stream reaches (such *as* pools and slower moving streams) clogs interstitial spaces in cobble and rubble fish habitat and can reduce pool volume, which in turn lowers production of fish, macroinvertebrates, and most other aquatic life. Suspended sediment also increases the cost of treating drinking water. Chemicals, such as pesticides, and nutrients often bind to sediment particles, thus they can be retained in the stream system rather than being flushed downstream. Too many suspended sediments can block or reflect sunlight before it reaches aquatic. plants. Heavier sediments can cover leaves, inhibiting photosynthesis, or even bury plants.

Turbidity *is* the measurement of the optical property which causes light to be scattered and absorbed. Turbidity *is* commonly measured in Jackson or Nephelometric Turbidity Units. There is no direct relationship between the two methods; therefore, there is no direct method of converting Jackson or Nephelometric Turbidity Units or vice versa. Turbidity can impair salmonid sight-feeding ability, reduce growth in salmonids, decrease primary productivity by reducing light penetration, and can contribute to an *increase* in stream temperature due to increased absorption of radiant energy.

Water quality requirements are usually *set* in turbidity units rather than in terms of sediment amounts. The general criteria established by the Environmental Protection Agency is that "settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life" (Environmental Protection Agency 1986). Chapter 340 of the Oregon Administrative Rules *sets a* standard of no more than a 10 percent cumulative increase in natural stream turbidities to be allowed, as measured relative to a control point immediately upstream of the turbidity-causing activity.

Bedload sediments are too heavy to be constantly suspended. The are rolled and bounced along the bottom of a stream. The size of *a* particle of bedload sediment will vary with the volume and speed of the water. Instream sediment levels, including bedload sediment, are both transport (flow) and supply dependent. Paustian and Beschta (1979), Jackson and Beschta (1982), and VanSickle and Beschta (1983) described bedload transport in terms of supply of material available for transport at various levels of flow; they found that most bedload transport occurred during short periods of high water, when flows were sufficient to entrain coarse, armoring riffle sediments, and access supplies of finer material within the riffle. Subsequent studies (Jackson and Beschta 1983) have demonstrated that increased amounts of sand in transport can cause previously stable, coarse riffle sediments to undergo scour. Stream bank erosion can also be a result of these peak flows. Increased high flow events can cause increased sediment concentrations and more frequent episodes of riffle scour and fill.

The effects of management activities on sediment transport are directly related to the effects on high flow events. The effect of management activities on the supply of sediment available for transport depends on the average slope of the sediment contributing area and the type of erosion processes dominant in the area of the activity. On gently sloping topography with competent (erosion resistant) bedrock, little, if any, increased erosion can be expected (Harr et al. 1979) as a result of management activities. On steeper slopes, surface erosion (known as dry ravel) occurs, especially after slash burning. It is not known how much of this eroded material reaches streams and becomes sediment.

Soil erosion is the main source of sediment in water. Some soil is eroded naturally through the weathering processes of rain and wind. However, the main causes of soil loss are agricultural practices, timber harvesting, road and building site construction, livestock grazing, and mining activities. Harr et al. (1979) reported that mean annual suspended sediment concentration in a clearcut watershed, without roads, was about nine times the natural concentration (in an undisturbed forest), and mean annual sediment concentration in a patchcut watershed, with roads, was about 23 times the natural concentration.

Timber management (road construction, timber harvest, and slash disposal) and other ground disturbing activities can affect sediment levels in streams by increasing the capacity of the streams to entrain and transport sediment and by increasing the supply of sediment available for transport. Increases in peak flows have a direct relationship to increases in sediment transported downstream. Forestry practices can also influence the sediment entering streams through surface erosion or landslides. This influence is dependent on natural rates of surface erosion and landslide frequency, climatic factors, and the type of activity. Timber harvest operations can damage stream banks, remove vegetation with roots that strengthens streambanks, widen stream banks, and lower surface water levels during low flow conditions. In areas where debris avalanching is the dominant erosion process, clearcutting has increased the natural rate of avalanching 2 to 4 times, and road building has increased the natural rate of erosion as much as 25 to 340 times (Harr et al. 1979).

Roads continue are a major source of stream sedimentation, although over the past 10 years improved methods for design, location, construction, and resurfacing dirt roads with rock have greatly reduced the amount of sediment contributed by roads. Surface erosion from cut and fill slopes, road surfaces, stream crossings, and drainage ditches can result in a continuous sediment source for nearby streams. Road construction can increase erosion as much as 250 times in the first storms following construction, however concentrations usually drop off between a few months and two years (Brown 1983). More extended periods of increased sediment can be associated with heavy truck road use during very wet weather, on poorly surfaced roads, or with unauthorized off-highway vehicle use.

Roads that encroach on stream channels permanently alter their flow characteristics by diverting or constricting the channel. Increased water velocities associated with constriction frequently lead to accelerated channel erosion. Road maintenance can remove riparian vegetation and disturb ditches and cutbanks that have been stabilized by vegetative ground cover. Skid roads, if located near streams, can contribute sediment if not properly waterbarred, seeded, or obliterated after use.

Livestock grazing can alter water quality by changing hydrologic conditions within a watershed, primarily those of surface cover and soil infiltration rates. Ground cover and the area of exposed soil can have the greatest influence on surface runoff, soil erosion, and pollutant transport. Moderate to heavy grazing by livestock can decrease infiltration rates and increase surface runoff, soil compaction, soil erosion, and sediment yields. More localized impacts of grazing on water quality result from stream bank sloughing (the collapse of stream banks) and the subsequent sediment that enters the stream channel. -

Mining activities can disturb large tracts of land, which can contribute to sediment problems. In addition, placer mining can involve removal of stream bank vegetation and the channelization of streams which can contribute great quantities of sediment to the channel.

Chemicals and Nutrients. Nutrients enter water mainly from treated municipal sewage discharges, failing septic tank systems, livestock operations (grazing or feed lots), and from fertilizers washed into the water by rain or irrigation. Excessive amounts of nutrients released into slow moving waters during spring and summer can result in growths of algae and aquatic weeds. Algae blooms reduce the amount of oxygen available to fish, which can result in fish kills. Shallow, nutrient-rich lakes often have impaired recreational and aesthetic values.

To address the problem of algae growth, the Oregon Environmental Quality Commission adopted a chlorophyll standard. The amount of chlorophyll in water indicates the amount of aquatic plant growth. Waters violating this standard will be studied by the Environmental Quality Commission to determine the nutrient sources and options for controlling the problem.

Timber harvest and slash disposal can affect the nutrient status of surface water. Clearcutting can disrupt the tight nutrient cycling of an undisturbed forest system, resulting in an accelerated breakdown of forest litter from increased temperatures and water content of the site. Once trees are removed they are no longer using the available nutrients, which can then enter surface waters through leaching or soil erosion. Slash burning can accelerate this process by making additional nutrients available for transport through volatilization and ashfall of organic material. In one Oregon Cascades watershed, instream concentrations of ammonia nitrogen and manganese reached peak levels of 7.6 and 0.44 milligrams per liter respectively following slash burning (Fredriksen 1971). Fredriksen attributed the high concentrations of ammonia nitrogen and manganese to burned slash in stream channels. However, the levels of these nutrients in streams rarely exceeds or approaches standards for those nutrients (Fellers and Kimmins 1984, Harr and Fredriksen 1988).

The aerial application of herbicides is another management activity that can affect the chemical water quality of streams. A detailed discussion of potential water quality impacts of herbicides proposed can be found in a variety of documents.

Application of nitrogen fertilizers also affects the chemical water quality of streams. Nitrogen is usually added to the soil by aerial application of urea pellets. Since direct fertilizer application is the major pathway for urea entry to streams, concentrations usually peak within one to two days following fertilizer treatment. Ammonia nitrogen also usually peaks shortly after treatment because it is a hydrolysis product of urea entering the stream.

Ammonia nitrogen in the soil is held very tightly, while nitrate nitrogen is readily leached from the soil. Leaching usually occurs after ammonia is oxidized to nitrate during the warm growing season. Therefore, peak nitrate concentrations are often recorded one to two years after fertilization. On the other hand, if nitrogen fertilizer is applied shortly after an area has burned, the warm soil temperatures can enhance nitrification and subsequent leaching of nitrate to the stream. Moore (1975) summarized several water quality monitoring studies on forest fertilization with urea throughout the Pacific

Northwest and found maximum recorded nitrate values were usually ***less*** than 1 milligrams per liter and in all cases were *less* than 5 milligrams per liter.

Ammonium-based fire retardants can adversely affect water quality. Studies have reported initial retardant concentrations in water approached levels that could damage fish. Concentrations decreased sharply with time after application and distance downstream (Norris and Webb 1989).

Natural background phosphorus in streams is contributed through leaf fall and other organic material, ground water leaching, and soil eroded into streams. The use of fertilizers, fire retardants, and herbicides can, in some instances, produce small and short-term increases in stream water phosphorus concentrations. Most published studies indicate that forest management activities have only limited, if any, effects on instream phosphorus levels (Salminen and Beschta 1991).

Dissolved heavy metals found in waters polluted by mine drainage are toxic to the aquatic biota. Toxic metals commonly released by mining are arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, and zinc. Synergistic toxicity *is* common in waters polluted by heavy metals from mining (Martin and Platts 1981).

Dissolved Oxygen. Oxygen is as essential to life in water as it is to life on land. Oxygen availability determines whether an aquatic organism will survive. and affects its growth and development. The amount of oxygen found in water is called the dissolved oxygen concentration and *is* measured in milligrams per liter of water. Dissolved oxygen levels are affected by altitude, water agitation, water temperature, the types of numbers of plants in the water, light penetration, and the amount of suspended sediments. Water absorbs oxygen from the atmosphere and the mixing of air and water in turbulent stretches of a stream both add significant amounts of oxygen to water.

Temperature directly affects the amount of oxygen in water-the colder the water, the more oxygen it can hold. Warming of water will cause reductions in dissolved oxygen levels. Oxygen can also be added to water as a result of plant photosynthesis. If photosynthesis is inhibited by sediments either by making the water murky or by burying leaves, then the plants will add *less* oxygen to the water. Instream concentrations of dissolved oxygen can be reduced by excessive amounts of organic debris entering streams during timber harvest. Once this organic material enters the channel, it can adversely affect dissolved oxygen concentrations in several ways: by exerting an increased biochemical oxygen demand; by restricting flow, reducing aeration, and by accentuating water temperature increases (Ponce 1978). When fine organic debris, such as small twigs and needles, is left in a stream, the contained sugars and phenols are leached out. The degradation of these materials by microorganisms present in the steam is a process of simple oxidation. Organism growth and metabolism create an increased oxygen demand, and oxygen concentrations decrease as demand exceeds supply (Ponce and Brown 1974). Too much fine organic debris in the stream can deplete dissolved oxygen concentrations at critical times of high stream temperatures, low flows, and low available oxygen. Most of the increased biochemical oxygen demand occurs within about 20 days of the time the material enters the stream (Ponce 1978).

Bacterial Contaminants. Bacterial contaminants most likely to be introduced into water bodies through natural processes and management activities (such as grazing and dispersed recreation) are total and fecal coliform, and fecal streptococcus. Concentrations of fecal contamination are important indicators of potential health hazards for domestic water supplies and water-contact recreation. Fecal contamination does not directly affect suitability of fish habitat, however, it can promote algal growth, which affects both fish habitat and the appearance of water. Levels of fecal coliform bacteria are known to increase in surface waters with the presence of livestock. Factors controlling the severity of fecal bacteria pollution and inputs of nutrients include the number of livestock, closeness of grazing to surface water, and the surface runoff conditions on areas being grazed. Bacterial concentrations tend to reach their peak during summer months when low flows combine with high recreation and livestock grazing use.

Macroinvertebrates. Macroinvertebrates are those invertebrates that can be detected with the unaided eye. Macroinvertebrates in the aquatic environment provide a link in the food chain between microscopic, multi-celled organisms and fish populations. They are essential to the growth and production of fish and because of their strict habitat requirements, are very useful indicators of aquatic habitat changes. The number, size, and species of aquatic invertebrates are important to fisheries habitat, *as* they are the primary food source for most salmonids and warm-water fish (Cooperrider et al. 1986).

A healthy stream usually has a rich and varied range of macroinvertebrates,' while streams with poor water quality will have just a few different species. The diversity of macroinvertebrates is important, but the types of organisms can also indicate water quality. Other factors also influence the type of aquatic organisms that can be found in the stream. Each organism has needs for habitat and food; if the stream does not have either, then the organism cannot live there. For example, some aquatic organisms feed on leaves or other organic material, others filter out small particles from the water, some scrape algae off of rocks, and some are predators that feed off of other macroinvertebrates. Also, some aquatic organisms attach to rocks, while others live in vegetation. If a macroinvertebrate is not found in an area where it has food and habitat available, then poor or stressful water quality conditions may be present.

The effects of forest management activities on macroinvertebrate communities vary. Increases in the riparian canopy opening or the amount of organic material in the stream generally enhance aquatic insect populations. An increase in fine sediment usually has the opposite effect. Removing the riparian canopy decreases the input of terrestrial organic material and the number of detritivores. However, this decline often is overwhelmed by the corresponding increase in primary production and herbivorous insects (Environmental Protection Agency 1991).

Macroinvertebrates, particularly benthic macroinvertebrates, have several characteristics which make them useful as indicators of water quality: they have either limited migration patterns or a sessile mode of life, which makes them suitable for assessing site-specific impacts; their life span (several months to several years) is long enough to be able to be used as indicators of past environmental conditions; and the sensitivity of aquatic insects to habitat and water quality changes often make them more effective indicators of stream impairment than chemical measurements (Environmental Protection Agency 1991).

Aquatic macroinvertebrate monitoring is a useful tool for evaluating general water quality condition and the extent to which designated uses are impaired or supported. To be most effective and reliable, however, biological studies need to be integrated into a monitoring plan that includes both physical and chemical evaluations.

For additional information regarding water resources *see* Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska (U.S. Environmental Protection Agency 1991), Study and Interpretation of the Chemical Characteristics of Natural Water (U.S. Geological Survey 1990), and Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams (U.S. Environmental Protection Agency, 1993).

Groundwater

Water that infiltrates the soil surface is known *as* groundwater. Most groundwater eventually discharges into stream channels, although some groundwater is found in layers called aquifers (water-bearing rocks or sediments that occur at depths from a few feet to several hundred feet below the surface). There are two types of aquifers: unconfined (also known as wate table aquifers) and confined (also known as artesian aquifers. Unconfined aquifers are generally shallow with an impermeable layer of rock or ***soil*** defining the lower boundary. The water table (saturated zone) *is* located between the impermeable layer and land surface. These shallow, unconfined aquifers are prone to contamination from surface pollutants. Confined aquifer are very deep below the soil surface and are separated from the surface by an impermeable layer of rock or soil. The quality of water in confined aquifers is generally excellent; however, in some cases, chemicals in the subsurface geologic formations can add undesirable contaminants, such as arsenic, boron, or sodium.

Groundwater is replenished by rain and snow, which filters through soil and geologic formations. This underground water generally moves slowly from mountains and uplands to lowlands and valleys, where it is discharged to creeks, rivers, and marshes, and provides the base flow for streams throughout Oregon. The discharge can vary significantly in different **areas,** depending on the nature of the aquifer.

Vegetation can influence groundwater in one of two ways. The presence of an abundant vegetation cover can decrease the amount of water stored in the soil through evapotranspiration. Conversely, vegetation can help the groundwater table to rise by improving infiltration and by reducing surface runoff. Water tables can rise after removal of vegetation due to increased water (from reduced transpiration) recharging groundwater areas. This effect can be negated by the reduction in the amount and rate of infiltration from removal o: soil surface cover and by disturbance during treatment of vegetation. Reductions in groundwater can also occur when subsurface flow is intercepted b: roads built in conjunction with vegetation management. Road cuts intercept precipitation and transports it as surface water through a ditch-culvert system. Some of this water is deposited on undisturbed soil areas where it returns to subsurface flow. The remainder is deposited into channels where it becomes streamflow.

WATERSHED MANAGEMENT

General

1. In watersheds where project scoping identifies an issue or concern regarding the cumulative effects of activities on water quality or stream channels, a cumulative effects assessment will be made. This will include land in all ownerships in the watershed. Activities on National Forest System lands in these watersheds should be dispersed in time and space to the extent practical and at least to the extent necessary to meet MR's. On intermingled ownerships, coordinate scheduling efforts to the extent practicable.

2. Table 22 identifies the percentage of each of the Forest's watersheds (tentatively suitable forested lands only) that can be impacted at any one time, unless more stringent guidelines are required by other resources. The guidelines will be applied in conjunction with regeneration harvest practices as well as other activities or events which significantly alter the vegetative condition of the watershed.

   Operational Considerations: These limits also apply to sub-basins within the watersheds listed in Table 22 that are larger than 10,000 acres in size. These percentages can be modified up or down based upon project or area hydrologic analysis. Areas will no longer be considered as contributors to watershed impacts when stocked with trees averaging, as a minimum, six feet in height and in sufficient numbers to provide 60 percent crown cover to the site.

Table 22. Watershed Impact Limits

WATERSHED	PERCENT OF AREA	ACRES[1]
Bridge Creek	35	16,000
Buck Creek	35	18,900
Chewaucan River	30	94,700
Crooked Creek	30	6,500
Dairy - Elder Creek	30	15,400
Deep Creek	30	24,300
Drews Creek	30	82,100
Goose Lake	30	43,900
Honey Creek	35	5,200
Lake Abert	35	32,800
McDowell Creek	35	5,700
Silver Creek	30	102,500
Silver Lake	50	262,900
South Creek	30	30,900
Sprague River - Middle	35	35,800
Sprague River - North Fork	35	118,300
Sprague River - South Fork	35	156,300
Sycan River - Middle	35	176,300
Sycan River - Upper	35	58,700
Thomas - Cottonwood	30	102,500
Tule Lake - Lost River	40	112,500
Twentymile Creek	35	5,100
Willow Creek	35	28,500

(1) Acreages calculated include both Federal, State and private lands within the National Forest boundary.

WATERSHED MANAGEMENT

3. Protection of Water Quality

Comply with state requirements in accordance with the Clean Water Act for protection of waters of the State of Oregon (Oregon Administrative Rules, Chapter 340-341) through planning, application, and monitoring of Best Management Practices (BMP's) in conformance with the Clean Water Act, regulations, and federal guidance issued thereto.

In cooperation with the State of Oregon, the Forest will use the following process:

1. Select and design BMP's based on site-specific conditions, technical, economic, and institutional feasibility, and the water quality standards for those waters potentially impacted.

2. Implement and enforce BMP's.

3. Monitor to ensure that practices are correctly applied as designed.

4. Monitor to determine the effectiveness of practices in meeting design expectations and in attaining water quality standards.

5. Evaluate monitoring results and mitigate where necessary to minimize impacts from activities where BMP's do not perform as expected.

6. Adjust BMP design standards and application when it is found that beneficial uses are not being protected and water quality standards are not being achieved to the desired level. Evaluate the appropriateness of water quality criteria for reasonably assuring protection of beneficial uses. Consider recommending adjustment of water quality standards.

Use the existing agreed-to process to implement the State Water Quality Management Plan on lands administered by the USFS as described in Memorandums of Understanding between:

The Oregon Department of Environmental Quality and U.S. Department of Agriculture, Forest Service (2/12/79 and 12/7/82), and "Attachments A and B" referred to in this MOU (Implementation Plan for Water Quality Planning on National Forest lands in the Pacific Northwest 12/78 and Best Management Practices for Range and Grazing Activities on Federal lands, respectively).

For a more complete explanation of the above, refer to Appendix H in the EIS, "Best Management Practices."

Individual, general Best Management Practices are described in *General Water Quality Best Management Practices*, Pacific Northwest Region, 11/88. This provides guidance but is not a direction document. Also included in this document is a description of the process and limitations and use of these BMP's. Each BMP listed includes the Title, Objectives, Explanation, Implementation and Responsibility, and Monitoring. Evaluations of ability to implement and estimated effectiveness are made at the project level.

Not all of the general BMP's listed will normally apply to a given project, and there may be specific BMP's which are not represented by a general BMP in this document.

The sensitivity of the project determines whether the site-specific BMP prescriptions are included in the EA/EIS or in the sale/project plan, or in the analysis files.

4. Protect climatological data collection sites from the influence of Forest activities.

   Operational Considerations: Maintain undisturbed buffer around all Forest Service or cooperative climatological data collection sites, i.e., weather stations, rain gauges, snow survey courses, snow telemetry sites (snow pillows) and aerial snow markers. The size of the buffer will be sufficient to protect the integrity of the site and will be determined on a case-by-case basis. On cooperative sites, agreements exist which define the size of the buffer.

Water Use and Rights

1. Use of water for National Forest purposes will be authorized under federal or state statutes depending on the location and purpose of use. Claims necessary under state statutes will be submitted in a timely manner. The Forest will cooperate with the state on Basin Adjudications as appropriate.

2. Recommended monthly instream flows for selected streams.

Table 23. Recommended[1] Monthly Instream Flow for Selected Streams

RECOMMENDED STREAMFLOW (cfs)[2] at Measurement Site													
STREAM	MEASUREMENT SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sprague River	Boundary USGS Gauge #11-4975	100	100	100	100	100	60	60	60	60	60	100	100
North Fork Sprague River	At Boulder Creek	50	50	50	150	150	40	20	15	15	50	50	50
Five Mile Creek	At Forest Boundary	10	10	10	20	20	20	15	15	15	15	10	10
North Fork Sprague River	1/2 Mile Above Sheepy Creek	20	20	30	80	80	40	20	10	10	10	15	15
South Fork Sprague River	At Sprague River Picnic Area	45	45	45	100	100	30	15	15	15	15	45	45
South Fork Sprague River	At Adler Creek	10	10	30	70	70	20	5	5	5	7	10	10
Deming Creek	Above Diversion Campbell Reservoir	10	10	10	10	10	5	1	1	5	10	10	10
Sycan River	At Forest Boundary	50	50	70	70	70	50	30	20	20	20	30	40
Sycan River	At Sycan Ford	50	50	70	70	70	60	30	20	20	20	30	40
Sycan River	At Forest Road 27	50	50	70	70	70	30	10	8	8	10	15	15
Sycan River	At Forest Road 3238	15	30	60	60	50	30	20	10	10	10	15	15
Long Creek (Winter Rim Side)	At Confluence with Sycan	3	3	6	6	6	3	1	1	1	2	3	3
Long Creek (Yamsay Mountain)	At Forest Road 2916	15	15	25	90	90	30	17	12	12	15	15	15
West Fork Silver Creek	At Forest Boundary	8	8	10	30	30	5	2	2	3	5	5	5
Bridge Creek	At Forest Boundary	4	4	5	10	15	10	5	2	2	5	5	4
Buck Creek	At Forest Boundary	8	8	12	15	30	30	8	8	8	10	10	8
Chewaucan River	At Forest Boundary	50	50	50	75	75	50	30	30	30	30	50	50

SEE END OF TABLE FOR FOOTNOTES.

Table 23. Continued. Recommended(1) Monthly Instream Flow for Selected Streams

RECOMMENDED STREAMFLOW (cfs)(2) at Measurement Site													
STREAM	**MEASUREMENT SITE**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dairy Creek	At Forest Road 28	20	20	30	50	50	25	20	20	20	20	20	20
Elder Creek	At Forest Road 33	8	10	12	25	25	12	6	4	4	8	6	6
Thomas Creek	At Forest Boundary	3	5	15	30	30	10	3	.5	.5	1	3	3
Honey Creek	At Forest Boundary	3	5	10	20	20	10	3	2	2	2	3	3

(1) Recommendations derived from previous Oregon Department of Fish and Wildlife data, modified by personnel from the Klamath Tribe, Winema National Forest, and Fremont National Forest.
(2) Cubic feet/second

Protection of instream flow needs may be achieved through: filing protests with the State Water Resource Department when applications are made that adversely affect National Forest resources, asserting claims for this water under federal or state laws where applicable, inserting protection measures into special use permits, or reaching formal agreements on use. Purchase of water rights and impoundments are other means for reducing these impacts.

Watershed Restoration

1. Degraded areas with a high potential for recovery will receive the highest priority for treatment. Structural treatments should be applied only when management changes are made concurrently, or when management changes have failed to achieve desired results within reasonable time frames.

   Operational Consideration: Planning and design of watershed and/or riparian restoration projects will be preceded by a thorough analysis of the tributary watershed by an interdisciplinary team.

Minerals Management

1. Protect floodplains, wetlands, and other riparian zones to the extent provided by law, through requirements in Plans of Operation and recommendations for protective lease stipulations.

2. Establish water monitoring stations in vicinity of active mines, leaseable mineral extraction sites, and exploratory areas if potential for chemical or physical water degradation exists.

3. Require timely stabilization of cuts, fills, overburden/waste material piles, and other disturbed areas.

MANAGEMENT AREA 15

Emphasis: Fish and Wildlife Habitat and Water Quality

Goals: Water bodies and courses, their riparian vegetation, and the immediately adjacent upland areas will be managed to maintain or improve water quality, fish habitat, recreation opportunities, and riparian habitat for dependent wildlife species.

Class I and II (perennial and intermittent) streams and water bodies with high recreation, fish, or wildlife values will be managed to provide the habitat capacity needed to meet the ODF&W trout management objectives. The long term goal is to approach the historical riparian condition.

Class III (perennial) streams will be managed, at a minimum, to maintain their existing water quality conditions and bank and channel stability.

Class IV (intermittent) streams will be managed, at a minimum, to ensure that the cumulative effects of land-disturbing activities will not jeopardize downstream objectives for perennial streams.

Wet and moist meadows in poor condition will be managed to obtain a fair or better range condition and a stable or upward trend. Meadows in good or better range condition will not be allowed to degrade to lower conditions. The long term goal is to approach the historical climax ecological condition.

Management emphasis for wet (CL-M1-11) and moist (CL-M3-11) lodgepole pine ecosystems will be to provide wildlife habitat.

Management Area Wide Standards and Guidelines

A. Applicable state and federal water quality standards will be met.

B. Site-specific prescriptions will be required for all project activities that affect aquatic/riparian systems (FSM 2526, R6 Supplement #42).

C. In cases of unresolvable conflict, soil, fish, water, and wildlife will receive preferential consideration.

D. Watershed, wildlife, and fisheries habitat rehabilitation and improvements will be required to meet goals for aquatic/riparian systems.

E. Nonforested riparian zones will be managed to increase the presence of late seral or climax vegetative community types.

F. Fencing of aquatic/riparian systems may be required when other means cannot meet management area goals.

G. Implement objectives and action items outlined in the Fremont National Forest Riparian Management Action Plan (see Appendix 7).

Standards and Guidelines Applicable to Specific Types within the Management Area

Perennial Streams and Water Bodies

all management activities

A. Management activities in and adjacent to Class I, II, and III perennial streams will be conducted so that all applicable state and federal water quality standards are met or exceeded.

1. Management activities will not cause a measurable increase in water temperature when daily high temperatures exceed the Oregon water quality standard of 58 degrees Fahrenheit (Klamath Basin), or 68 degrees Fahrenheit (all other Fremont National Forest basins) on all perennial streams.

2. Project activities will be conducted in a manner to ensure that turbidity levels do not exceed ten percent of pre-activity levels on Class I, II, and III streams. Short-term violations for required in-stream construction work (i.e., restoraion measures, bridges, etc.) are acceptable.

timber management

A. The SMU or WMU occupied by tentatively suitable forest land will be managed on low intensity uneven-aged management for pine and pine-associated stands or a 120-year rotation for lodgepole pine stands.

B. Management of the SMU or WMU will be directed toward providing or meeting the following:

1. Conditions or characteristics

(a) an abundance of mature/overmature trees

(b) diversity in conifer and deciduous tree species

(c) diversity in age classes

(d) an abundance of deciduous shrubs and trees

(e) high (composite) canopy closure - shade to stream

(f) retain: at least 1.5 snags of 10 to 20 inches d.b.h. and 1 snag greater than 20 inches per acre and at least 2 down logs per acre of 12 inch diameter on the small end and 25 feet in length with the bark and sapwood intact

(g) high amount of large woody debris in the stream channel and upper and lower banks, for stream channel and bank stability and structural fish habitat

2. Management treatments

(a) infrequent disturbance of soil/duff

(b) single tree/group selection harvest

(c) trees growing into lower and upper banks should be retained

(d) minimal amount of equipment disturbance-use in riparian areas

(e) prescriptions will be designed to increase residual density as the stream is approached

(f) no heavy equipment movement up and down stream channels, SMU, or WMU areas during fire suppression or logging activities; perpendicular crossings permitted, but rehabilitation required

(g) allow natural accumulations of dead wood debris; treat only large accumulations that hinder meeting riparian, water, or wildlife objectives

(h) instream construction will take place in accordance with time periods outlined in "Guidelines for Timing of Instream Construction, Fremont National Forest"

range management

A. The SMU's or WMU's subject to livestock grazing will be managed so they do not exceed the following use levels for the forage component.

Table 31. Riparian Areas, Forage Utilization[1] and Allowable Use of Forage[2]

Range Resource FRES[3] Management Level (FSH 2209.21 R-6)	Maximum Annual Utilization (percent) Grass and Grasslike[4] S[6]	U[7]	Shrubs[5] S[6]	U[7]
B. Livestock use managed within current grazing capacity by riding, herding, and salting, cost-effective improvements used only to maintain stewardship of range.	40	0-30	30	0-25
C. Livestock managed to achieve full utilization of allocated forage. Management systems designed to obtain distribution and maintain plant vigor include fencing and water developments.	45	0-35	40	0-30
D. Livestock managed to optimize forage production and utilization. Cost-effective culture practices improving forage supply, forage use, and livestock distribution may be combined with fencing and water developments to implement complex grazing systems.	50	0-40	50	0-35

(1) This will guide development of annual operating plans and will be used where allotment management plans do not address allowable use. Allotment management plans may include utilization standards which are either lower or rarely higher when associated with intensive grazing systems and specific vegetation management objectives which will meet resource objectives for the riparian dependent resources. Includes cumulative annual use by big game and livestock.
(2) Allowable use of forage is based on the amount of forage that will be left at the end of the overall grazing season or the end of the growing season, whichever is later.
(3) Forest Range Environmental Study
(4) Utilization based on percent removed by weight.
(5) Utilization based on incidence of use, weight and/or twig length. For example, if 50 leaders out of 100 are browsed, utilization is 50%.
(6) Satisfactory condition is determined by allotment classification and/or forage condition.
(7) Unsatisfactory condition is anything not meeting satisfactory conditions.

B. Specific riparian objectives designed to meet a variety of resource needs will be developed by an interdisciplinary team on an allotment basis.

landownership adjustments

A. Emphasize retention of National Forest System lands adjacent to major watercourses.

transportation management

A. Construction of parallel roads will be minimized in the SMU of Class I, II, and III perennial streams or the WMU of lakes with high recreational, wildlife, or fisheries values.

B. Arch or box culverts with open bottoms or bridges will normally be required on all Class I and II perennial streams on permanent road systems, to allow for fish passage.

C. Existing roads within the SMU which parallel Class I, II, or III perennial streams will be relocated on an opportunity basis. Abandoned roadbeds will be rehabilitated.

fire management

A. Machine constructed fire lines should not be constructed in riparian areas during fire suppression activities. Perpendicular crossings, with subsequent rehabilitation, are permitted, but discouraged if alternatives exist.

B. Use of prescribed fire will be limited to:

1. Burning of activity fuels located in the upland portion of the SMU.

2. Burning of natural fuels for the purpose of enhancing riparian dependent values.

fish and wildlife management

A. Reservoirs will be planned for fisheries and other compatible uses where feasible.

B. As a minimum, instream fisheries habitat improvement will be coordinated with range, watershed, recreation, and the ODF&W. Objectives will be developed based upon the Fremont National Forest "Rise to the Future" Plan.

Intermittent Streams

all management activities

A. The riparian portion of the SMU will be managed to provide the following:

1. Conditions or characteristics

(a) an abundance of trees greater than six inches d.b.h.

(b) high amounts of naturally occurring large woody debris in the stream channel and upper and lower banks

(c) high levels of herbaceous and shrub vegetation (as measured against potential)

2. Management treatments

(a) trees growing into lower and upper banks are usually retained

(b) single tree or group selection harvests - preferred

(c) soil and duff disturbance minimized (minimal amount of equipment disturbance)

(d) stream channels and riparian areas will not be used for skid trails or landings

(e) new roads will not be constructed in the riparian area of the SMU and generally will not be constructed in the upland portion of the SMU

(f) no heavy equipment movement up and down stream channels and riparian areas during fire suppression and logging

(g) perpendicular crossings permitted but rehabilitation required

Ephemeral Draws

all management activities

A. The bottoms of ephemeral draws will not be used for skid trails, landing sites, or as road locations. Equipment disturbance of duff land soil will be minimized.

Seeps and Springs

all management activities

A. Management of seeps and springs will be directed toward providing or meeting the following in the riparian portion:

1. Conditions or characteristics:

   (a) an abundance of deciduous trees or shrubs

   (b) an abundance of standing dead trees

   (c) an abundance of conifer trees greater than ten inches d.b.h.

   (d) good water flow and quality

2. Management treatments:

   (a) single tree or group selection harvest - generally

   (b) infrequent soil/duff disturbance

   (c) no equipment disturbance except for restoration or improvement

Moist Lodgepole

timber management

A. The timber in each moist lodgepole pine area will be harvested on a 100-year rotation schedule (no more than ten percent of an area cut per decade).

Wet Lodgepole

timber management

A. These sites are classified as unsuitable. Timber harvest will not be scheduled.

9. <u>Interim Wildlife Standard</u>:

The interim wildlife standard has two possible scenarios to follow based on the HRV for each biophysical environment within a given watershed:

a. SCENARIO A: If watershed conditions for the old and late structural stage in a particular biophysical environment falls BELOW the Historic Range of Variability, DO NOT allow harvest activities to occur within old and late structural stage stands, and ENHANCE old and late structural conditions in "younger" stands as much as possible.

1) Activities are allowed outside of old and late structural stage stands ONLY IF THEY ARE DESIGNED TO MAINTAIN AND ENHANCE EXISTING OLD AND LATE STRUCTURAL COMPONENTS. Silvicultural systems and cutting methods should be consistent with the principal features of historical disturbance regimes.

a) Maintain all remnant old and late seral structural live trees ≥21" dbh that currently exist within stands proposed for harvest activities.

b) Manipulate vegetative structure that does not meet old and late structural conditions in a manner that moves it towards these structural conditions as soon as possible.

c) Maintain open, parklike stands (average canopy density <30%) of ponderosa pine with average tree diameters of ≥15". Do not manipulate the dominant overstory that creates this structure, but manipulate the understory, if needed, to encourage the maintenance of the large diameter, open canopy ponderosa pine structure. However, some amount of pine seedlings, saplings, and poles should be present as an understory.

d) Treatment methods will mimic historical disturbance regimes as much as possible.

2) MAINTAIN connectivity and reduce fragmentation of old and late structural stage stands because wildlife species associated with late and old structural conditions DEPEND on the connectivity of these habitats to allow free movement and interaction of adults and dispersal of young. Connectivity is one of the key habitat components needed to insure species viability. Until a full conservation assessment is completed that describes in more detail the movement patterns and needs of various species and communities of species in east-side ecosystems, it is critical to insure that blocks of habitat maintain a high degree of connectivity between them, and that blocks of habitat do not become fragmented in the short-term.

a) Maintain or enhance the CURRENT LEVEL of connectivity between old and late structural stage stands and between all Forest Plan designated "old growth/MR" habitats.

b) Connectivity is considered "adequately met" when all four of the following items are met:

(1) old and late structural stage stands and MR habitats are connected with other like stands inside the watershed and to adjacent watersheds in a network pattern, and

(2) each old and late structural stand and MR area should be connected with others at least 2 different ways, (3 ways are preferred), and

(3) "connection corridors" between these habitats need to be made by stands of trees with $\geq$ 9" dbh and canopy closures $\geq$50%. If site potential does not allow canopy closure of $\geq$50%, maintain canopy closures within the top 1/3 of site potential. The intent is to maintain canopy closure as dense as possible. Stand widths must be at least 400 ft. wide at their narrowest point. For those lodgepole pine stands that are not capable of meeting the $\geq$9" dbh size, utilize the best available mature and stocked stands as "connection corridors." Seedling/sapling dbh's should not be included in the average dbh calculations.

(4) the distance between old and late structural stands and MR habitats that are connected through corridors should be $\leq$ 1.5 miles.

c) To insure connectivity as described above is maintained, use the following process:

(1) Do suitable network linkages between old and late structural stands and MR-designated habitats occur, according to the previous description? If so, will the proposed project isolate any area or group of areas by reducing any one of the parameters below acceptable levels? If not, the project can continue. If so, the project must be deferred or re-designed to meet connectivity parameters described above.

(2) Do suitable network linkages between old and late structural stands and MR-designated habitats NOT OCCUR under current conditions, as described above? If areas are already isolated, or partially isolated by not meeting the connectivity description above, will the proposed prescription promote linkage sooner than if left alone? If so, the project should continue. If the project is designed in a manner that would further increase isolation, the project must be deferred or re-designed to enhance connectivity parameters.

d) To reduce fragmentation, or at least not increase it from current levels, stands in earlier seral conditions that are located within larger blocks of old and late structural stands should not be considered for even-aged regeneration at this time. Non-regeneration activities in these areas should only proceed if the prescription moves the stand towards old and late structural conditions as soon as possible.

3) ADHERE to the following specific wildlife prescriptions in order to maintain options for species conservation in the future. These standards are set at MINIMUM levels of consideration. Follow Forest Plan standards and guidelines when they EXCEED the following prescriptive levels:

a) *Snags and Down Logs*: Most (if not all) old forest associated species rely on moderate to high levels of snags and down logs for nesting, roosting, denning and feeding. Large down logs are a common and important component of old and late structural, un-managed stands. Past management practices have greatly reduced the number of LARGE snags and down logs in managed stands.

(1) All sale activities (including regeneration, select cutting, thinning, or salvage) will maintain snags and green replacement/roost trees of $\geq$ 15 inches dbh at 100% potential population levels of primary cavity

excavators. (This should be determined using the best available data on species requirements as applied through current snag models or other documented procedures.)

For lodgepole pine stands, all sale activities will maintain snags and green replacement/roost trees of $\geq$ 10 inches dbh at 100% potential population levels of cavity excavators. The largest available trees should be left to meet this requirement. These requirements should be determined using the best available data on species requirements as applied through current snag models or other documented procedures.

(2) For all stands, snags $\geq$ 20 inches dbh are preferred and should be left whenever possible, with snags down to the 15 inch category being left when larger snags are not available.

(3) Live reminant trees $\geq$21" dbh should be left and considered part of the green tree "replacement" tree and roost tree requirement.

(4) Leave pre-activity (currently existing) levels of down logs, unless they exceed the quantities listed below. Harvest activities shouldsupplement pre-activity levels of down logs up to the maximum level shown below. Exceptions can be made where fire protection needs for life and property cannot be accomplished with this quantity of debris left on site.

This down log criteria is not intended to preclude the use of prescribed burning as an activity fuels modification treatment. Fire prescription parameters will ensure that consumption will not exceed 3 inches total (1 1/2 inch per side) of diameter reduction in the featured large logs (sizes below). Tools such as the CONSUME and FOFEM computer models, fire behavior nomograms, and local fire effects documentation can aid in diameter reduction estimates.

SPECIES	PCS. PER ACRE	DIA. SMALL END	PIECE LENGTH & TOTAL LINEAL LENGTH	
Ponderosa Pine	3-6	12"	>6 ft.	20-40 ft.
Mixed Conifer	15-20	12"	>6 ft.	100-140 ft.
Lodgepole Pine	15-20	8"	>8 ft.	120-160 ft.

b) Goshawks: The following standards are MINIMUM levels of consideration. Forest Plan standards and guidelines that EXCEED the levels described below should be used instead of the following:

1) Protect every known active and historically used goshawk nest-site from disturbance. "Historical" refers to known nesting activity occurring at the site in the last 5 years. Seasonal restrictions on activities near nest sites will be required for activity types that may disturb or harrass pair while bonding and nesting.

2) 30 acres of the most suitable nesting habitat surrounding all active and historical the nest tree(s) will be deferred from harvest.